Bowdoin-King Partnership

Four-Week Unit: Standards-Targets-Assessments (STA) Plan

Title *(Indicate the unifying factor for this set of STAs, e.g. expedition, series of lessons)*	Exploring Sound
Grade level	8th Grade
Discipline(s)	Technology Education
Dates	
Author(s)	Roya Moussapour

Standards	Long-Term Targets & Essential Questions	Supporting Targets (3-5 max. per long-term target)	Assessments FOR Learning (Formative)	Assessments OF Learning (Summative)
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. **MP.2:** Reason abstractly and quantitatively.	**EQ:** Where do we hear sound in our everyday lives? **LT:** I can describe and explain how sound is produced in different materials.	(1) I can differentiate between higher and lower pitches and volumes. (2) I can identify the relationship between the following: pitch and frequency, as well as volume and amplitude. (3) I can illustrate and explain to someone else the association between frequency and wavelength.	**Activity (LTs 1, 2):** Students will brainstorm independently and record on paper where they hear sounds in their everyday lives (noises, talking, music, cars, etc.). Students will then share their ideas with another student. At the end, the pairs will share what they've come up with, paying attention to not repeat other pairs' suggestions. **Check for understanding:** During brainstorm and paired work, teacher will walk through class to listen in on student responses and check for understanding of task. During class share, teacher will elicit responses from groups creating a healthy list of possible answers, challenging students to only offer answers not yet provided. Teacher can assess individual and group responses while students learn from each other.	**Activity (LT 3):** Students will conduct an experiment by manipulating the amount of water in a bottle and blowing across them. Students will write down the frequency of the pitch heard by using a computer or phone app to determine this measurement. Students will then be asked to share their findings (this should include something in regards to the relationship between the amount of air space and pitch) in some manner. This may include pictures, graphs, or a written form. **Check for understanding:** Review students' results and submissions, provide feedback.

			Activity (LT 1): Teacher will demonstrate different instruments in class and cold call on students to describe the sounds they hear. Students do not need to describe sound in musical terms; it would be ideal for students to describe sounds as "loud, soft, harsh, smooth." Students will then try instruments in small groups and take turns describing sound. Each group should generate a written list of words used to describe the sounds, building upon the one started with the initial discussion on everyday sounds. **Check for understanding:** Teacher will be able to push initial conversation in different ways depending on initial student responses - teacher can ask students to use different vocabulary or think more critically about the way in which they compare sounds. Teacher will then walk around between groups to listen to students' discussions and ask questions to challenge students to expand their descriptive vocabulary. **Activity (LTs 1, 2):** Students will be given vocabulary building worksheets outlining many acoustics-related words: frequency, wavelength, amplitude, compression, rarefraction, oscillation, vibration etc.	

			Worksheets will differ: some will be more visually structured with less text, some will have vocabulary words underlined in writing, some will have images and full definitions for vocabulary words. Students will write initial definitions of vocabulary words (diagnostic activity). Teacher will then show Youtube video (https://www.youtube.com/watch?v=YNE6zeLqEyU, until 1:32) to class. Students will watch video and describe their new understanding of words. **Check for understanding:** While students are working, teacher will walk around answering questions and checking how students are completing the material. After class, teacher will review collected worksheets to see how students are progressing with using vocabulary and see how students' definitions compare with their initial definitions and understandings of these words. **Activity (LT 2):** In a subsequent class to vocabulary exercises, students will begin class with a "do now" or entrance ticket asking students to define and use 2-3 key vocabulary words in sentences from a list posted on the board. Students will then be invited to come up to the front of the room to write their sentences on the whiteboard. Teacher will then ask	

			students to explain their definitions and guide further discussion of vocabulary words to stress importance of using authentic scientific vocabulary in acoustics work. **Check for understanding:** Teacher leads a discussion where students read sentences on the board and discuss changes that may or may not need to be made so that vocabulary words are used correctly. Teacher will encourage student corrections of work on board when possible and support process when needed. The written review of the "do now" allows the teacher to assess and identify individual students who may need additional support prior to advancing to more complex material involving more frequent use of foundational vocabulary. **Activity (LTs 2, 3):** Teacher will provide a dataset to students on different wavelengths of sound and their corresponding frequencies and students will work in groups to talk about how the data are related (Does the frequency go up as wavelength goes down, or does the opposite happen?) Teacher will provide models of ways in which to structure the data, whether pictorially, graphically, or in writing. In groups of three to four, students will have a chance to apply teacher-led model ideas and create their	

			own representations of the data. They will be asked to share briefly an explanation of their thinking that guided how they organized their data. **Check for understanding:** Teacher will hear how students are describing the relationship between frequency and wavelength in groups. Teacher will be able to provide feedback through comments to students on how well they are communicating their findings as well as on the physical representations students make.	

Rationale for Long-Term Target: Sound is something that is all around us every day, and yet, it is not something often discussed outside of an academic or musical setting. Students get to begin a unit on acoustics by working on understanding sound in both qualitative and quantitative ways. Students should be able to discuss the way sound originates in various media (air, metal, wood) based on different instruments to compare and contrast sound production methods. Students will also be able to make observations about instruments to discuss qualitative characteristics of sound such as pitch and volume. These ideas will fuel future discovery in working with various types of instruments, but also provide a point at which all students can participate, regardless of whether they play an instrument.

Rationale for Essential Question: This EQ is a broad question that will drive much of the unit's discovery. Sound waves are a fundamental topic in physics in the more general study of waves, and this question allows for qualitative and quantitative discussion of the topic. The first week of the unit will introduce this EQ as something to think about throughout the unit; how is sound produced and how do different instruments or objects produce sound? What sounds do we hear in the world around us? This is a natural question for students to ask about the world in which they live. Scientists are focused on learning about how the world works, how our surroundings function as a system, and sound is one of the most accessible ways for students to begin to research the world around them in this way. Through creating portfolios to share at the celebration of learning, students will ultimately circle back to the idea of understanding sounds in their lives by working on a number of formative and summative assessments looking at explaining sound in various ways.

Rationale for Formative Assessments: These assessments are a combination of worksheets, experiments, and group discussions. This allows students to learn and strengthen their understanding of topics through multiple entrance points. Students will need to have an understanding of certain vocabulary in learning about the physics of sound, and this first week will be used as a foundation-builder to give students the background they need to tackle graphically depicting

waves and instrument design. These assessments are important because they provide ways for learners of all kinds to interact with and demonstrate their understanding of the material in a variety of ways. They provide feedback for students frequently so students are able to reflect on their own development.

Rationale for Summative Assessments:

One of the most important relationships in acoustics is the relationship between wavelength and frequency in a given medium, $v = \lambda * f$. Students will experiment with bottles to see how the length of the air cavity within a bottle affects the frequency heard when you blow across the top of a bottle. By taking data and making measurements, they are participating in authentic scientific work. Students will be able to use the data they have acquired in a number of ways to show the relationship between frequency and wavelength and can choose how they would like to exhibit their knowledge. The mathematical relationship studied is paramount in understanding how different musical instruments work. This summary activity is an excellent representation of the initial EQ and an understanding of it impacts something in one's everyday life - music. Those who design instruments must have an understanding of the relationship between frequency and wavelength. This work will ultimately contribute to a portfolio of work shared during the celebration of learning.

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. CCSS.ELA-LITERACY.RST.6-8.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a	EQ: How can we represent pitch and volume without making a sound? LT: I can model pitch and volume in sound waves using graphs.	(1) I can measure the amplitude and wavelength of a wave graphed in space. (2) I can measure the amplitude and frequency of a wave graphed over time. (3) I can graph a wave over time and label the components of my graph. (4) I can graph a wave in space and label the components of my graph.	**Activity (LTs 1, 2):** Students will work independently on their computers using online applets (https://phet.colorado.edu/en/simulations/category/physics/sound-and-waves) to look at waves on a vibrating string. Students will be given differentiated notecatchers to organize their thoughts and observations about frequency and amplitude. Following this individual work, students will pair up to tiny teach what they have learned the previous week about frequency, wavelength, and amplitude based on what observations they made while using the applet and what they recorded in their notecatchers. Teacher will write questions on the board that students should discuss.	**Activity:** Students will work in assigned groups together to create graphs of waves in space and waves over time. Teacher will give each group different wavelength, frequency, and amplitude and students will work together to draw graphs on posterboard, labeling parts of the graph with aspects such as amplitude, wavelength, frequency, the axes, and a title. Students will present these graphs to their classmates and discuss the process that informed how they were created. **Check for understanding:** Teacher will provide written

flowchart, diagram, model, graph, or table). HOWL: I work cooperatively with others.			**Check for understanding:** Teacher will walk around classroom listening to discussions and providing live comments on explanations. Teacher will give students opportunity to share with the whole class if they so choose to allow students to share their thoughts with a larger audience. **Activity (LTs 2, 3, 4):** Students will be given graphs individually (graphs divided into four groups) and be asked to determine the amplitude, wavelength, and frequency of the graphs using guidelines provided. Students will then move into groups based on the graphs they were given and will compare the ways in which they measured different parts of the graph. Teacher will then invite students to share their graphs and ensure that all students are given the opportunity to share their methodology. **Check for understanding:** Teacher will walk around classroom answering students' questions and asking clarifying or challenge questions of students when they are working individually and when they are working in groups. Teacher will ask students to do a fist-to-five on how comfortable they feel interpreting graphs to guide accessibility of summative assessment. Presentations	comments and feedback on students' presentations using a rubric similar to the final celebration of learning presentation rubric. During whole class presentations, teacher will ask class to provide three positive comments and one constructive comment to each presenting group on material presented and collaborative presentation skills shown by students.

			will also offer an opportunity to assess overall understanding of content.	

Rationale for Long-Term Target: Designing curriculum from the view of teaching students to be scientists requires students to participate in work done by scientists; in this case, working with graphing waves. Most generally, graphing is something done frequently by scientists to look at relationships between variables they are studying. Authentic, scientific work leads students to an understanding of what happens in the discipline of science. By interpreting graphs, creating graphs, and explaining them through writing, students are participating in authentic scientific work, learning to explain their discoveries and work to others.

Rationale for Essential Question: This question is almost a brain-teaser in a sense in that it leads students to wonder about what sound could possibly be without the aural experience of hearing sound. It is broad enough to allow students to puzzle over it, but specific enough that students (with some introduction of the topic) can figure out what expressing sound without hearing sound can be. Students can think of a variety of ways to represent sound without hearing; most simply, through graphs, but also in other ways such as vibrations (for those who are hearing-impaired). This EQ gives students another perspective and pushes students towards thinking about the idea of sound from multiple viewpoints, broadening their views of the field of acoustics.

Rationale for Formative Assessments: These formative assessments will allow students to work independently and collaboratively, building on the knowledge they have acquired in the beginning of the unit. By beginning with solidifying past knowledge through teaching each other, students practice presenting work to others, a skill they will draw on many times throughout the unit. Students will then build on skills to prepare them for their next summative assessment; by learning to interpret graphical representations of waves, students engage with graphical representations that they will then create and share with the class. Students will also be able to practice presenting on a smaller scale to prepare for final presentations at the end of the unit, something scientists do frequently in research projects. It is also important for students to be practicing these skills to fully take advantage of the design and engineering process, a step-by-step process that can help students organize their ideas and hypotheses.

Rationale for Summative Assessments: Graphing waves and presenting to the class will be a precursor to final presentations at the end and will also be a portion of a portfolio of work students have created through the unit. They will build presentation skills and graphical abilities through the summative assessment. It's important for students to have feedback on their presentation abilities prior to a final presentation on the subject they're studying, so having a similar experience presenting research with a smaller amount of material than a whole unit portfolio is beneficial to students. Incorporating in peer feedback (both positive and constructive) allows the presentations to be a group effort.

MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well	EQ: How is sound produced by musical instruments?	(1) I can use internet research as a tool to support my instrument design.	**Activity (LT 1):** Students will fill out structured notecatchers by using internet research on musical instrument design. Students will be asked to use different sources to write about pipe, string, and	**Activity (LTs 1, 2, 3)**: Students will build musical instruments individually. Students will have multiple options for building instruments, including:

they meet the criteria and constraints of the problem. HOWL: I learn from feedback and revise my work. HOWL: I work cooperatively with others.	LT: I can design and engineer a musical instrument.	(2) I can sketch a draft for my musical instrument. (3) I can build a musical instrument that plays at least two different pitches.	mallet instruments. Notecatchers will be differentiated so that students can choose to engage in research they feel comfortably challenged by: one will ask students to find their own sources and information on varying topics, one will give sources and ask students to summarize important information, another may provide important vocabulary to comprehend specific articles. Students will then be asked to think independently on how their research will affect their instrument design; students will share their thoughts with other students and then do a fist-to-five on how prepared they feel to begin designing instruments. **Check for understanding:** Teacher will walk around and help with research notecatchers. Teacher will have conversations with students about their research as they share it with other students. Teacher will use fist-to-five to gauge class understanding of task. **Activity (LT 2):** Students will sketch out designs for their musical instruments that include measurements of different parts, what materials will be used for their instruments, and labels for different portions of their instruments. Students will share their sketches with partners and	a) PVC pipe instruments looking at how the length of a vibrating space affects the frequency b) rubber band guitar looking at how tension of strings affects frequency heard c) xylophone looking at how length of keys affects frequency heard. Students will submit an artifact of their work demonstrating their use of the design and engineering process and the research they did to inform decisions about instrument design; this could be a powerpoint, a written piece, an illustration of their step-by-step process, or another agreed upon ahead of time with the teacher. Teacher will provide models for students of instruments, summary pieces, and rubrics to help guide and inform how students should prepare and present their material. **Check for understanding:** Teacher will review submissions as well as help students throughout the process in formulating and organizing

			fill out peer critiques prior to building instruments. **Check for understanding:** Students evaluate each other's designs to provide feedback. Teacher will walk around during peer review to help provide commentary if students do not understand task or do not provide adequate feedback.	their ideas and questions about the project.

Rationale for Long-Term Target: This LT summarizes the main objective for the second half of the unit, to design and create a musical instrument. This process integrates the knowledge built in the first half of the unit understanding sound waves and sound production into the design process for musical instruments. This is important for its aspect of experimentation; the design and engineering process is directly applicable to a situation in which students are designing real instruments and allows students to make observations, do research, make hypotheses, and try solutions to solve the task of building an instrument. This LT encapsulates the supporting learning targets, providing a longer-term goal for students to work towards in designing their instruments. This LT targets the standard MS-ETS1-2 in having students revise and edit their work throughout the design and engineering process.

Rationale for Essential Question: This EQ enables students to apply their knowledge about sound waves and production of sound to musical instruments and question how they can make the connection between a more theoretical understanding about waves and a more applied process of instrument design. Musical instruments produce sound in varying waves depending on whether they are string instruments, wind instruments, percussion instruments, etc. and learning about their differences allows students to be more critical thinkers about the world around them. It is important for students to make greater connections between what they are learning in school and their extended community and, since music is such a culturally relevant topic for many cultures around the world, it is a great topic to which students can relate and use for experimentation.

Rationale for Formative Assessments: By beginning with students conducting research to learn about different kinds of instruments and work on formatting their thoughts cohesively through guided notecatcher-based research, students can build skills directly applicable to work that scientists do on a daily basis. Students will work on both understanding how instruments produce sound and how to design and engineer solutions (or instruments in this case). This will promote the step-by-step nature of the design and engineering process, as students will not be able to proceed in the construction of their instruments until they have outlined their own building process. This is an important process for students to use, as not only is it organized and step-by-step (important skills for students to have in life), but is also introducing students to the work of engineers and scientists. Students will also work in groups on critiquing each other's work - this directly focuses on the HOWLs "I learn from feedback and revise my work" and " I work cooperatively with others."

Four-Week Unit:
Standards-Targets-Assessments (STA) Plan

Rationale for Summative Assessments: The actual summative assessment for this portion of the unit will not be completed until the final week, but will build on students' abilities to use the design and engineering process to create musical instruments based on a set of requirements. It will build into a portfolio presentation for a celebration of learning at the end of the unit. See more on this rationale below.				
CCSS.ELA-LITERACY.W.8.7: Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. HOWL: I learn from feedback and revise my work. HOWL: I work cooperatively with others.	EQ: How is sound produced by musical instruments? LT: I can present and explain my experimental results to an audience.	(1) I can revise my musical instrument's design by using peer critiques. (2) I can summarize the design process of my musical instrument. (3) I can guide an audience through the design process of my musical instrument.	**Activity (LT 1):** Once students have begun to build instruments, they will participate in written peer feedback in order to modify their instruments. Students will be paired up with someone different from the first peer review in order to get another perspective on their instruments. **Check for understanding:** Teacher will provide feedback on peer critique sheet for both students, adding feedback on how to improve the instruments and providing modeling for feedback delivery. **Activity (LT 2):** In preparing for final presentations during celebration of learning, students will have a "do now" reviewing vocabulary from first week and asking them to think about how to make a connection between the acoustics they have learned (concepts and vocabulary) and their musical instruments. Teacher will help students brainstorm a list of students' responses on the board based off the "do now" exercise. Teacher will give students a few minutes to reflect on their work and the "connections" on the board, making notes about what they may want to integrate into their own	**Activity: Continuation of instrument design and construction.** **Activity:** Students will prepare presentations for the celebration of learning summarizing the work they have completed through the unit on acoustics and instrument design. Students will not be graded on the work they completed in the past on graphing and mathematical representation, but on the musical instrument design and the presentations themselves. Students will present different portions of the unit: the initial sound exploration, the $v = \lambda * f$ relationship, graphing waves in space and over time. Each student in the group will then briefly describe their design process for their instrument. **Check for understanding:** Teacher will provide feedback for students through individual and group assessment rubrics

			presentations and reminding students that their presentation must make these connections explicitly. **Check for understanding:** Teacher will have students discuss their ideas through putting them up on the board. Teacher will be able to evaluate how well students synthesized acoustics topics through the creation of instruments. **Activity (LTs 2, 3):** Students will be assigned to groups to create presentations about the scientific practices in which they've engaged through the unit. Students will be able to choose the specific parts of the unit (bottles, graphing, vocabulary/foundation-building) they would like to present to allow students more comfortable with certain aspects to present what they feel confident about. All students will present their instruments to the ultimate audience. When students have created their presentations in their groups, they will practice presenting in front of the class as a whole to prepare for the celebration of learning presentations. **Check for understanding:** Teacher will guide discussion of feedback after every group has presented and provide written comments on a previously shared rubric to groups.	that students have received prior to presentations.

Four-Week Unit:
Standards-Targets-Assessments (STA) Plan

Rationale for Long-Term Target: Students will be able to present their findings throughout the unit to an audience through a celebration of learning at the end of the unit. Presentation skills will be developed throughout the unit in order to present research findings. This will allow students to act as scientists do in sharing their work with a public audience. Leading up to the celebration of learning, students will work on modifying their work based on others' suggestions, learning to give and receive feedback and constructive criticism. The actual musical instrument design enables students with different learning styles to interact with the material on a deep level, studying the relationship between sound production from the first two weeks of the unit and musical instruments. Presenting work to an audience asks students to take their knowledge and share it with others in a way to help others attain a greater understanding of their unit; this is authentic scientific presentation work.

Rationale for Essential Question: Outlined above (same EQ).

Rationale for Formative Assessments: Formative assessments for this section of the unit will focus on both the experimental aspects of instrument design and scientific research as well as preparation for scientific presentations. Students will continue to work both independently and collaboratively through reviewing each other's work, targeting both HOWLs (as previously mentioned). Preparing for portfolio presentations in groups requires students to synthesize material they have been working on throughout the unit in conjunction with their musical instruments.

Rationale for Summative Assessments: Much like scientists do, students will be able to share their research findings and their instruments with a public audience. Students will primarily be responsible for the actual instruments they create and displaying the hypothesizing, research, and design work that led to the instruments, but will also present their findings to their peers, other academic community members, and the greater public community of friends and family. This will allow students to take pride in their findings and share them in the ways in which scientists share research.