Unit Synopsis

The anchor phenomenon of the features of a concert venue is introduced to students who watch a concert video and generate a list of important features found in a concert venue. They explore visual representation of the sound, ask questions, make predictions, and model their initial explanation of the sound produced by a music box, explore devices that might make sound, view visual representations of them, and revise their initial model of the music box sound.

Students create a pendulum with a period of 1 second by manipulating mass, angle, and length of the pendulum. The pendulum will serve as a model and discussion foundation for wave properties, and students explore how changing one part of a dynamic system affects the rest of the system.

Students make observations about the polarization of light and using writing and drawings they describe how polarized sunglasses work. They complete investigative stations involving refraction, reflection, absorption, and transmission. They discuss the interactions between objects and light, and analyze the characteristics of light and waves.

The unit continues with students exploring color phenomena, including Vantablack and Newton's Color Disc. Students are introduced to the electromagnetic spectrum focusing on visible light. They build a spectroscope and perform an activity with it. Then students complete a wave table activity observing reflection, absorption, and diffraction of waves.

Students will compare and contrast analog waves vs digital waves and then use the Phyphox app (found in the Science Buddies lesson within LS5) to record their voices measuring decibel levels. The two types of waves created in the Phyphox app will model the difference between analog and digital waves.

Finally, students create a model in which they use the information they have obtained to synthesize the use of sound and light waves in a culminating performance, in which they design a concert venue and event that allows attendees to experience the concert in a variety of ways (sound, lights, motion, etc.).

To access the flowchart for this unit, click here.

Suggested Pacing:
25 - 27 hrs

Anchoring Phenomenon/Design Problem:
Features of a Concert Venue

Unit Driving Question:
How can the science behind light and sound be used to design and carry out the ultimate musical concert experience?

Culminating Performance Task:
Designing the Ultimate Concert Experience - Students will be able to demonstrate their understanding of sound and light waves by creating a model of an orchestrated production that will include music synchronized with light.

NGSS Performance Expectations: (Hyperlinks will bring reader to NGSS Evidence Statements)

- 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.]
- 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.]
- MS-PS4-3. 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.
    - [Clarification Statement: Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen.]
    - [Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.]

- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Three Dimensions that form the Foundation for these NGSS Performance Expectations:

Science & Engineering Practices:

Using Mathematics and Computational Thinking
- Use mathematical representations to describe and/or support scientific conclusions and design solutions.

Developing and Using Models
- Develop and use a model to describe phenomena.
- Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.

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.

Engaging in Argument from Evidence
- Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.

Disciplinary Core Ideas:

PS4.A: Wave Properties
- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.
- A sound wave needs a medium through which it is transmitted.

PS4.B: Electromagnetic Radiation
- When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light.
- The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends.
- A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media.
- However, because light can travel through space, it cannot be a matter wave, like sound or water waves.

PS4.C: Information Technologies and Instrumentation
- Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information than analog signals.

ETS1.B: Developing Possible Solutions
- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.
- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.
- Models of all kinds are important for testing solutions.

Crosscutting Concepts:

Patterns
- Graphs and charts can be used to identify patterns in data.

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.

	ETS1.C: Optimizing the Design Solution • The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.	

Possible Common Core State Standards Connections:

ELA/Literacy -

- RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
- SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
- SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS4-1)(MS-PS4-2)(MS-ETS1-4)
- WHST.6-8.1.C Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
- WHST.6-8.1.E Provide a concluding statement or section that follows from and supports the argument presented.
- WHST.6-8.2.B Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.
- WHST.6-8.2.D Use precise language and domain-specific vocabulary to inform about or explain the topic.
- WHST.6-8.2.F Provide a concluding statement or section that follows from and supports the information or explanation presented.

Mathematics -

- MP.2 Reason abstractly and quantitatively. (MS-PS4-1)(MS-ETS1-2)(MS-ETS1-4)
- 8.F.B.4 Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (*x, y*) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

PROGRESSION OF LEARNING

Learning Sequence 1:

- **Learning Sequence Driving Question:**
  - How can sound be heard and audio spectrums seen?
- Learning Sequence 1
- **Relationship to Anchoring Phenomena/Design Problem**
  - This is the introduction to the anchoring phenomenon of the features of a concert venue.
- **Student Expected Outcomes:**
  - Students will generate a list of features of a concert venue.
  - Students will create a model of how sound is transmitted.
  - Students will consider how an audio spectrum is able to be seen.

Learning Sequence 2:

- **Learning Sequence Driving Question:**
  - What are the parts of a wave, and how can a basic understanding of waves be used to design a 1-second pendulum?
- Learning Sequence 2
- **Relationship to Anchoring Phenomena/Design Problem**
  - The anchoring phenomenon of the features of a concert venue is related to sound and light waves. Students learn about waves by working with pendulums and online simulators.
- **Student Expected Outcomes:**
  - Students will test a variable to determine its effect on the period of a pendulum.
  - Students will identify the period, frequency, and amplitude of a wave.
  - Students will design and construct a 1-second pendulum
  - Students will collect data and use it to calculate changes needed in their 1-second pendulum design.

Learning Sequence 3:

- **Learning Sequence Driving Question:**

- What are the properties of waves, and what are the differences in sound and light waves?
- Learning Sequence 3
- **Relationship to Anchoring Phenomena/Design Problem**
    - Students explore light and sound waves which are both involved with the anchoring phenomenon.
- **Student Expected Outcomes:**
    - Students will identify and explain the characteristics of light related to refraction, reflection, absorption, and transmission.
    - Students will describe how polarized sunglasses work.
    - Students explain the differences between sound and light waves and how they travel.

Learning Sequence 4:
- **Learning Sequence Driving Question:**
    - What happens to light waves as they travel and how are they visible?
- Learning Sequence 4
- **Relationship to Anchoring Phenomena/Design Problem**
    - The ability to see the many facets of a live concert can be explained by the visible light segment of the Electromagnetic Spectrum.
- **Student Expected Outcomes:**
    - Students will investigate the properties of waves and how they travel.
    - Students will investigate the electromagnetic spectrum and waves that are visible and not visible.
    - Students will recognize that invisible wavelengths of light can have visible effects on both living and nonliving things (sunburn, microwave cooking, etc.).
    - Students will explore the science behind color as they look at the bending of light through a medium, such as a prism that separates the individual colors.

Learning Sequence 5:
- **Learning Sequence Driving Question:**
    - Why might you prefer watching TV produced with a digital signal vs. an analog signal?
- Learning Sequence 5
- **Relationship to Anchoring Phenomena/Design Problem**
    - Both the sound and light of the anchoring phenomenon travel in waves. The sound waves in the phenomenon can be transmitted either with digital or analog signals. Using waves to carry digital signals is a more reliable way to encode and transmit information than using waves to carry analog signals.
- **Student Expected Outcomes:**
    - Students will gather sufficient evidence to support a claim that includes the idea that using waves to carry digital signals is a more reliable way to encode and transmit information than using waves to carry analog signals.
    - Students will be able to demonstrate their understanding of sound and light waves by creating a model of an orchestrated production that will include music synchronized with light (the model will be displayed on a tri-fold chart or students will culminate their learning in an authentic performance).

Assessments:
- Culminating Performance Task
    - Students choose a song and design a concert space for that song. Students discuss and jointly develop the design criteria and constraints for creating their wave concert models. This includes the shape and material composition of the space and its furniture, where to place speakers, and coordinating lighting to the song.

- Grade 8 Assessment Tasks and Rubrics
- 2019-2020 - G3-G8 Interim Assessment Blocks (IABS) by CREC Bundle

Additional Resources:
- Materials List 2020
    - Click on specific tab for unit-specific materials