Overview

Tool Kit I
Good Vibrations – The Science of Sound

How are vibrations related to musical sound?

a. Explore the physics of sound, including basic wave theory.
b. Formulate predictions and make observations about how sound travels through various mediums.

Tool Kit II
Organology – The Science and Study of Musical Instruments

How can we classify musical instruments?

a. Discover the science of organology, which is the study of musical instruments and their design characteristics, including the Hornbostel-Sachs method of instrument classification.
b. Contribute to a collaborative organological discussion using appropriate detail and evidence to support arguments.

Tool Kit III
Industrial Design – Imagining New Musical Instruments

If you could invent a new musical instrument, what would it be like?

a. Invent a new musical instrument using principles of industrial design.
b. Investigate a wide variety of interdisciplinary STEM topics related to the design of your musical instrument.
c. Present your research findings in a design proposal.

Extend the Learning
As an extension, students can explore MIM's Advanced STEM Curriculum, which includes projects that explore acoustic and electronic amplification, electronic sound synthesis, and the interplay of technological innovation and musical aesthetics.

Museum Collection Highlights, Vocabulary, and Concepts

- Energy
- Sound Wave
- Amplitude
- Frequency
- Wavelength
- Speed
- Medium
- Wave Propagation
- Compression
- Rarefaction
- Idiophone
- Chordophone
- Aerophone
- Membranophone
- Electrophone
- Corpophone
- Mechanical Music Gallery
- Recycled Orchestra
- Steinway Piano
- *Octobasse*

Students use a Slinky to discover the motion of longitudinal waves.

Field Trip
During a field trip to MIM, students will see, hear, and play musical instruments from around the world, which provide real-world examples of the physics of sound. Students will learn about the characteristics of sound waves (amplitude, wavelength, speed, and frequency) and the biology of the human ear as well as explore the technological innovations that have created diverse musical cultures throughout the world.

Book a field trip at MIM.org/field-trips!

Standards Addressed

The following project-based learning activities were designed to introduce concepts and practices of the sciences as they relate to music; however, numerous interdisciplinary connections and extensions to these activities are also possible. Embedded STEM learning facilitates inquiry across numerous disciplines, a few examples of which are listed below:

Arizona Science Standards

- Strand 1
  - Inquiry Process
- Strand 2
  - History of Science as a Human Endeavor
- Strand 3
  - Science in Personal and Social Perspectives
- Strand 4
  - Life Sciences
- Strand 5
  - Physical Science
- Strand 6
  - Earth and Space Science

Arizona Social Studies Standards

- Strands 1 and 2
  - American History and World History
- Strand 4
  - Geography

Arizona Mathematics Standards

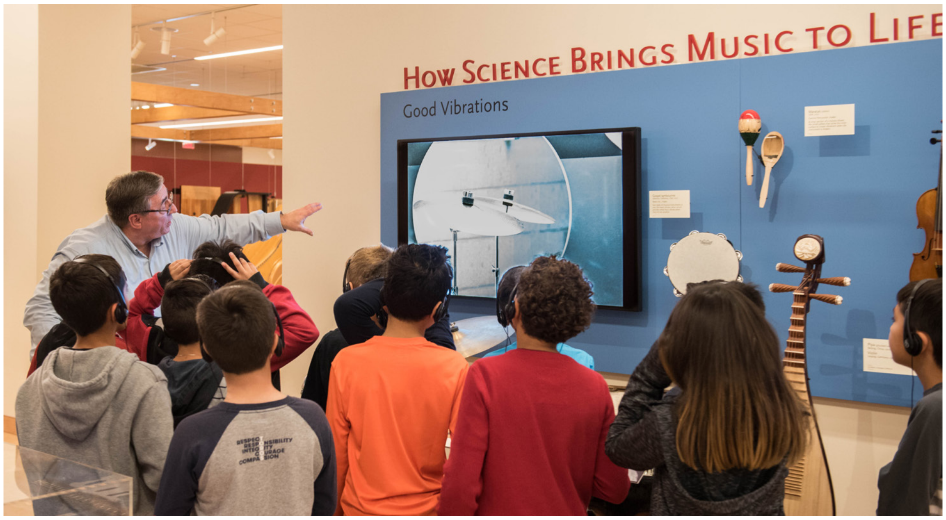
- Measurement and Data
- Ratios and Proportional Relationships
- Algebra
- Geometry
- Functions

English Language Arts

- Reading Standards
  - Informational Text
  - Foundational Skills
- Writing Standards
- Knowledge
- Language
- Writing
  - Opinion Pieces

Arizona Academic Standards in Arts

- Creating
- Presenting
- Responding
- Connecting



Tool Kit I
Good Vibrations – The Science of Sound

Objective
Explore the physical properties of sound, including basic wave theory and the concepts of energy transfer.

Materials
- An oven rack, cooling rack, or other similar lightweight metal object
- String
- Slinkys
- Bungee cords

Arizona Science Standards Addressed
Strand 1: Inquiry Process
- Concept 1: Observations, Questions, and Hypotheses
- Concept 2: Scientific Testing (Investigating and Modeling)
- Concept 3: Analysis and Conclusions
- Concept 4: Communication

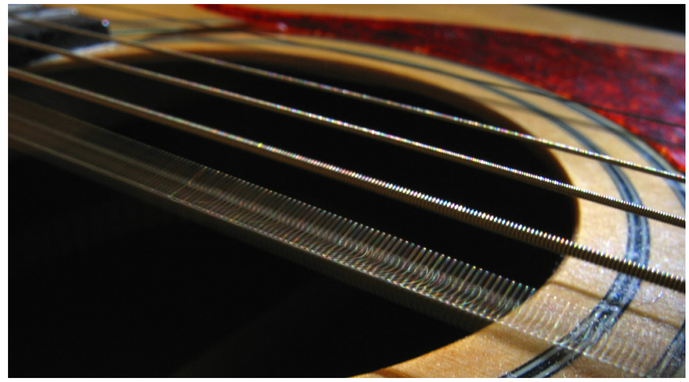
Strand 5: Physical Science
- Concept 1: Properties of Objects and Materials
- Concept 2: Position and Motion of Objects
- Concept 3: Energy and Magnetism

Background Information for Educators

What is sound? How does it relate to music? Sound occurs when energy interacts with any object in such a way as to force it to vibrate (e.g., move back and forth rapidly). For sound to occur, we need three things:

1. **A source of energy**
2. **Vibrations**
3. **A medium for those vibrations to travel through**

A source of energy might come from finger plucking a guitar string, air blowing across a saxophone reed, or hitting a drumhead. That energy creates a disturbance

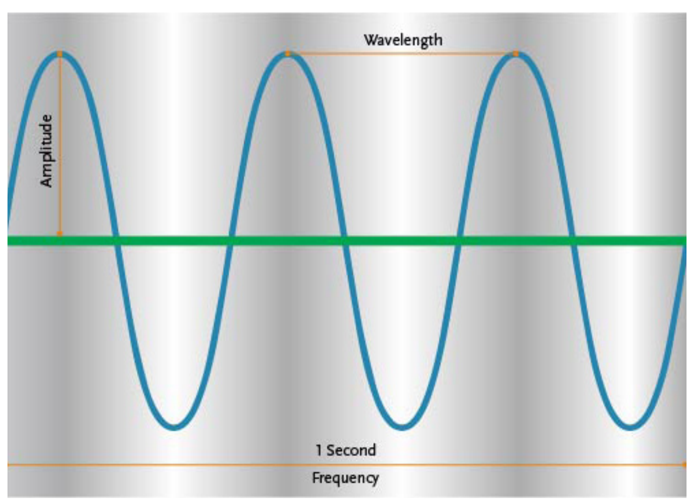


A guitar string models the up-and-down motion of a transverse wave.

that causes the string, reed, or drumhead to vibrate. These vibrations can be transferred from one medium to another. For example, a guitar string vibrates causing the wood in the guitar to also vibrate, which then causes the air surrounding the guitar to vibrate, thus creating sound waves. These sound waves then cause your eardrum to vibrate, which sends a signal to your brain that gets interpreted as sound. Sound waves, like waves at the beach or waves anywhere else, have the following key characteristics:

1. **Amplitude**
2. **Wavelength**
3. **Speed**
4. **Frequency**

The **amplitude** of the wave indicates the amount of energy the wave carries. For example, if you hit a

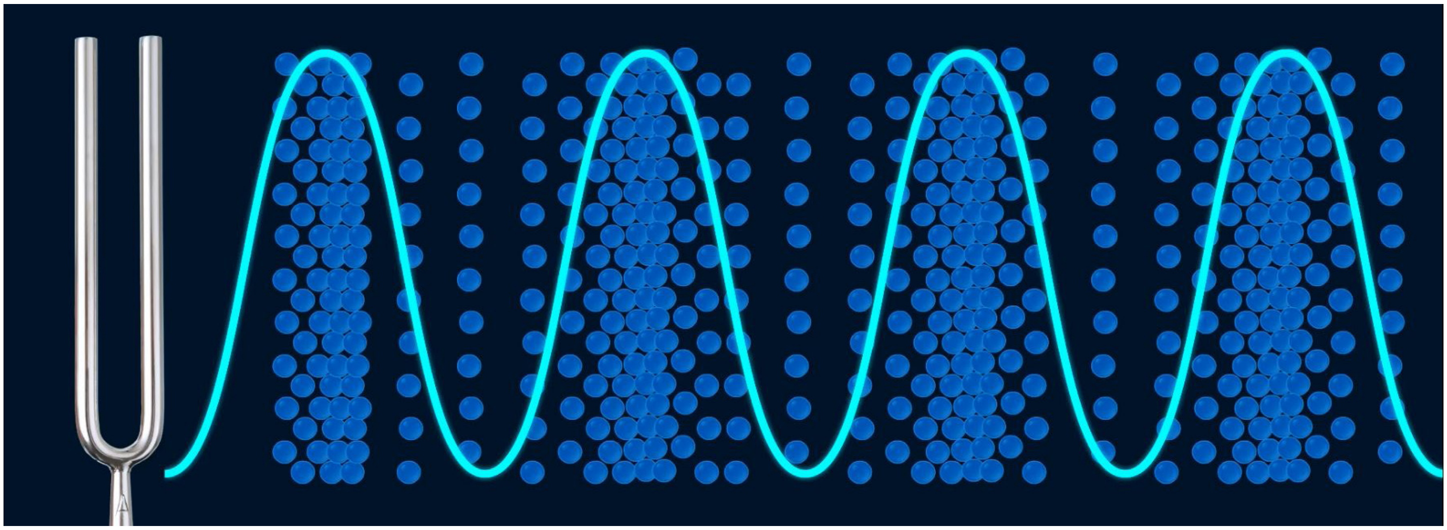


Waves can be described by their frequency, amplitude, wavelength, and speed.

drum with a lot of energy, the drumhead will move up and down a greater distance than if you gently tap the drum. The amplitude of the resulting sound wave will directly correlate to how hard, or soft, you've hit the drum. Amplitude can also be thought about as loudness: the greater the amplitude, the louder the sound. If we were to graph that sound wave, the wave with higher amplitude would have a taller crest (or "peak") than the wave with lower amplitude. You can also see amplitude while at the beach. A ten-foot ocean wave will carry significantly more energy than the little waves you might see in a lake.

waterfalls, roaring lions, subwoofers, big drums, or huge organ pipes. High frequencies correspond to the high, shrill sounds we hear—birds, squeaking mice, flutes, soprano singers, or tiny organ pipes.

There are many different types of waves. The manner in which a wave transports its energy, called **propagation**, is a distinguishing characteristic for each different type of wave and is directly related to the **medium** through which a wave can propagate. A sound wave propagating through a solid medium, such as a guitar string or drumhead, causes up-and-down motion, creating



The compression and rarefaction of a longitudinal wave traveling through air

Wavelength is a measure of the distance between each successive repetition of a wave. Again, if we were to graph a wave, the wavelength would be represented by measuring the distance between each crest (or "peak") of the wave. The **speed** of a wave is the measure of how fast the wave itself is traveling. Waves travel at different speeds if they are traveling through air, water, or a solid object such as wood. **Frequency** is the measure of how often a wave is observed repeating in a specific measure of time; it is directly related to wave speed and inversely related to wavelength. For example, as wave speed increases, frequency will also increase. Inversely, if the wavelength increases, the frequency will decrease.

Frequency is commonly measured in hertz (Hz), which is a measure of how often a wave pattern repeats in one second. Low frequencies correspond to the low, rumbling sounds we hear in music and nature—

crests and troughs, just like on our graphed wave above. This is called a **transverse wave**. Conversely, a sound wave propagating through the air causes air molecules to alternatively bunch up or separate in a process known as **compression** and **rarefaction**. This is called a **longitudinal wave**. A visual representation of the compression and rarefaction of a longitudinal sound wave, together with an overlay of how that wave would be graphically represented, can be seen below.

Both longitudinal and transverse waves are known as **mechanical waves** as they propagate through physical interactions with the mediums in which they travel. In other words, molecules are mechanically displaced as they propagate. **Electromagnetic waves** are another class of waves that enable the propagation of wave energy using charged particles called **electrons**. Personal electronic devices, such as cell phones, electronic recording devices, and electric or electrically amplified musical instruments, all transfer energy between electromagnetic and mechanical waves in order to create sound. For further details on electronics, electromagnetism, and sound, see MIM's advanced STEM curriculum.

Observe, Question, Hypothesize, Test, Model, Analyze, and Explain

Choose from the following activities to facilitate the process of scientific inquiry of the basic principles of waves, wave properties, and wave propagation through various mediums, such as liquids, solids, and air.

Activity 1: ZOMBIE SOUNDS – The Basic Principles of Waves

Invite all students to stand in a circle holding hands and pretend to be zombies. Invite one or two students to be "zombie masters," which we'll call **energy**. Energy causes the zombies to start slowly to move in a circle, making low, zombie-type sounds. Energy also causes **vibrations** that students can feel in their throats as they make zombie sounds. Duck down and make soft zombie sounds or on tiptoes and make loud zombie sounds. Invite two students to exit the circle and become "zombie hunters" who will "scare" the zombies. When zombies are scared, they move quickly, still walking on their heels in a circle, making high-pitched squealing noises.

Invite two more students to be "zombie scientists." Using their two hands (or a paper roll) to form a

Students pretend to be zombies while learning about the basic physics of waves.

"science tube," the scientists are tasked with observing, testing, and analyzing the following:

How "frequently" does a zombie's head pass in front of the science tube when the zombies are scared versus when they are not scared?

Do the zombies sound louder when they are crouched over or standing on their tippy-toes?

Holding hands, you represent a **wave** form with heads being the point of compression ("crest") and hands being the point of rarefaction ("trough"). When you move quickly, your "heads" pass in front of the "science tube" (or **oscilloscope**) with greater **frequency** than when you move slowly. Hunched over, you represent a wave of lower **amplitude**, which sounds "softer" than when you're on your tiptoes and represent a "loud" wave of greater amplitude.

Note: for the purposes of this basic activity, differentiating between wave types or nomenclature is not a curricular aim.

Extensions

Different groups of zombies can **transfer** their wave energy from one to another.

Different groups of zombies can represent different **mediums** through which wave energy might travel. Remember that sound travels faster through solid mediums (zombies can stand very close to one another and move very quickly) compared to liquids or gases (zombies can stand farther apart and move more slowly).

Different **wavelengths** can be modeled by how closely zombies stand while holding hands.

The interaction of **wavelength**, **frequency**, and **speed** can be modeled by having zombies stand close together and move slowly and by having zombies stand far apart but move quickly—with heads passing in front of an "oscilloscope" at about the same rate. While both waves will exhibit the same frequency ("heads passing in front of the oscilloscope"), the wavelength and speed are obviously very different.

Longitudinal waves can be mimicked by having zombies all stand shoulder to shoulder in a line. One zombie on the end pushes against the zombie next to him/her, causing a chain reaction of the push to travel through the entire group of zombies. The energy of the wave moves "longitudinally" along the line of zombies.

Transverse waves can be mimicked by having zombies move their arms in an up-and-down, wave-like motion, just as one would see at a sporting event. The energy of the wave moves up and down, perpendicularly, or "transverse" to the line of zombies.

The differences between **mechanical waves** and **electromagnetic waves** can be illustrated by having the zombie masters or hunters use flashlight signals to start or alter a zombie wave. Light waves are a form of electromagnetic energy.

Activity 2:
EXTRA-LONG STRING – The Basic Principles of Waves (Transverse Waves)

Have two students hold each end of a long string or bungee cord and pull it tight, then have a third student, positioned in the middle, "pluck" the middle of the string. You can't hear a sound, but you can see the up-and-down motion of the **transverse wave** that is being created. Have students describe what they're seeing and initiate a discussion about sound wave characteristics.

How does the motion of the extra-long string compare to the graphic of the wave? Is it the same shape? How does it differ from the wave motion observed in the Slinky?

Both the graphic and the extra-long string are visual representations of a wave.

Rope can easily model the up-and-down motion of transverse waves.

Extensions

Have a fourth student hold a midpoint of the string while the outer two students maintain the same tension on the string, then have the third student pluck the string again.

How do the vibrations of the string change? Does the string vibrate faster or slower? Is the frequency higher or lower?

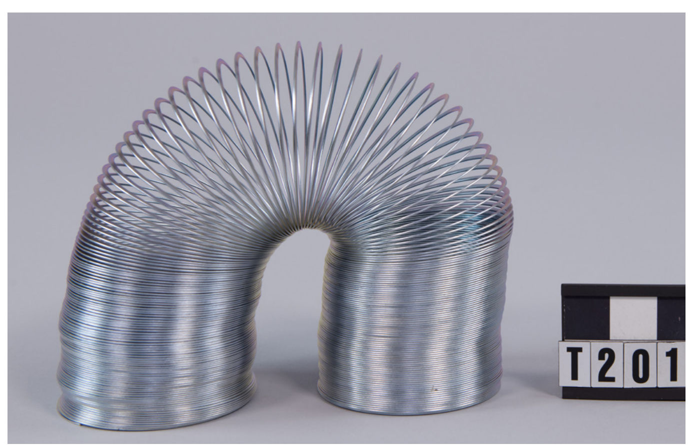
By holding a midpoint of the string, you effectively shorten it just as you do while playing many string instruments. A shorter string will vibrate at a higher frequency than a longer string, assuming both strings are held at the same tension.

Activity 3:
SLINKY WAVES – Longitudinal Waves

When a sound wave moves through air as a **longitudinal** wave, air molecules bunch up and spread apart in a process known as compression and rarefaction. Have two students stretch a Slinky across a smooth surface such as a table. Then, have a third student take a rung in the middle of the Slinky and, while keeping the Slinky on the table, pull it either to the left or the right, and then release it (like a slingshot). Ask the students to describe what they're seeing.

What happens if the rung is pulled farther to the right or left? What happens if a middle rung is grabbed versus a rung close to either end?

Energy causes air molecules to get pushed closer together, then spread farther apart, just like the Slinky



Slinkys can model the compression and rarefaction of a longitudinal wave.

rungs. This makes areas of high and low pressure. This process of compression and rarefaction is propagated back and forth along the Slinky until the energy dissipates. Sound will propagate through air in the same way until its energy dissipates. When the energy dissipates, you hear no more sound.

Activity 4: COOLING-RACK GONG – Energy, Vibrations, Medium, Transfer

Tie string or yarn to a metal structure, such as a cooling rack (used for cakes or cookies) or even a wire coat hanger, leaving two pieces of string, each about two feet long, hanging loosely. Wrap one loose end of the string around each index finger, and then stick your fingers in your ears. Stand up so that the rack hangs in front of you, bend over slightly and knock the wire structure against a hard object such as a table or chair. A gong-like sound is heard, but only by the person holding the string in his or her ears.

Why does only the person with the string wrapped around his/her finger hear the sound?

The cooling rack is heard only by the person holding it.

The string (a solid) transmits vibrations much better than air does, so the person with the string hears sounds no one else can.

Activity 5: TUNING FORKS – Energy, Vibrations, Medium, Transfer (Surface Waves)

Holding the tuning fork by the small end, strike the pronged end on the bottom of your shoe. Ask the students to observe what they hear.

What happens if you hold the tuning fork in the air near your ear?

What happens if you place the small end of the tuning fork on a hard surface such as your desk?

What happens if you place the small end of the tuning fork on your skull bones just on either side of your ear?

Can you describe the different mediums through which the energy of the sound waves is propagating?

A tuning fork transfers its vibrational energy to the water surrounding it causing small ripples.

Holding the tuning fork near your ear will enable your ear to hear only the sound waves propagating through the air. Holding the tuning fork against a hard surface such as a desk will transfer some of that energy to that hard surface and then to the air, possibly getting more air molecules to vibrate and increasing the loudness and amplitude of the sound. Holding the tuning fork against the bones on your skull will transfer some of that energy, via your bones and soft tissues, directly to your ear.

Extensions

What will happen if you place the pronged end of the tuning fork partway into a glass of water?

The vibrations from the tuning fork are transferred to the water, creating tiny waves across the top of the water. Waves that travel across the surface of a liquid are known as surface waves. Surface waves are characterized by the circular motion of the energy being propagated along the wave. You can see the circular motion of a surface wave in action at the beach when a wave crashes into a circular tube.

Activity 6:
"DO YOU HEAR WHAT I HEAR?" –
Energy, Vibrations, Medium, Transfer, and Alteration

What we hear is altered by the mediums through which sound waves propagate energy.

Students on a field trip discover how amplitude, or loudness, can damage their hearing.

Field trip participants discover the inner workings of the human ear in MIM's STEM Gallery.

Students record a short message on a tape or digital recorder. Play the message back.

Students rate how similar or different the recorded voice sounds from the voice heard in their head.

The speaker will generally say that the recorded voice sounds very different from the "real" voice, while other students will say that the recorded voice sounds quite similar. This is because of the way sound waves travel differently through solids and liquids. When you hear someone else speak, you hear only the sound waves that travel through the air to your eardrums. When you hear yourself speak, you hear not only the sound waves that travel through the air but also the sound waves that travel through the liquids and solids of your own bones and tissues. As a result, you hear your own voice differently from anyone else.

At MIM, learn more about the perception of sound and the human ear in a exhibit called "How Science Brings Music to Life" in the Collier STEM Gallery.

Assessment

Formative

Students explain or physically model their understanding of wave theory through responses to and interactions with one another and the teacher/ facilitator.

Summative

Students can explain the basic components of wave theory, including amplitude, wavelength, speed, and frequency. Students can also explain the differences between longitudinal and transverse waves. Students can explain further how different mediums, through which sound waves propagate energy, can alter the resulting sound we hear.

Tool Kit II

Organology – The Study of Musical Instruments

Objective

Explore the classification of musical instruments, also known as the science of organology, and refine the understanding of how musical instruments produce sounds.

Materials

- MIM organology flash cards
- Post-it notes or similar

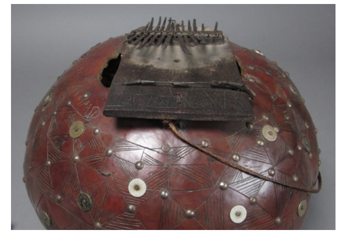
Arizona Science Standards Addressed

- Strand 2: History of Science as a Human Endeavor
  - Concept 1: History of Science as a Human Endeavor
  - Concept 2: Nature of Scientific Knowledge
- Strand 3: Science in Personal and Social Perspectives
  - Concept 2: Science and Technology in Society
- Strand 5: Physical Science
  - Concept 1: Properties of Objects and Materials

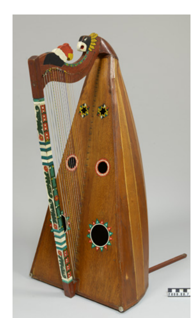
Background Information for Educators

Musical instruments can be classified in many ways. Some instruments make loud sounds, others soft sounds. Some instruments are made of wood, others of metal. Some instruments play very high notes, others very low notes. Some instruments are played in specific ensembles or used to create specific genres of music, others are used universally, across genres and cultures. The science of organology classifies musical instruments by identifying what generates the vibrations that create the sound. Known as the Hornbostel-Sachs system, the six organological families of instruments are:

Idiophone "Ideo" means personal. Idiophones produce their sound by setting up vibrations in the body of the instrument itself. Examples at MIM include instruments such as steel pans, handbells, and thumb pianos.



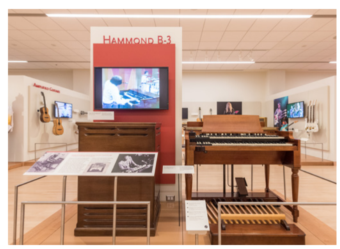
Chordophone "Chordo" means rope or string. Chordophones produce sound by setting up vibrations on a stretched string. Examples at MIM include instruments such as the violin, guitar, harp, and piano.



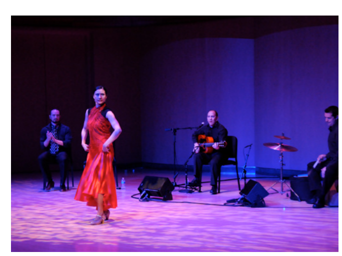
Membranophone “Membrano” means skin. Membranophones produce their sound by setting up vibrations in a stretched membrane. Examples at MIM include drums from all over the world.

Aerophone “Aero” means air. Aerophones produce their sound by setting up vibrations in a body of air; they can also be thought of as vibrating columns of air. Examples at MIM include many flutes and the pipe organ.

Electrophone “Electro” means electric. Electrophones produce sound primarily from electricity. As a result, they often require an amplifier and speaker to be heard. Some electrophones, such as the electric guitar, could fit in two categories (chordophone and electrophone). Examples of electrophones at MIM include the turntable, theremin, and Hammond organ.



Corpophone “Corpo” means body. Corpophones are “body sounders,” in which a vibration or action is produced by a body part (or parts). Examples include handclaps, slaps on the body, snaps of the fingers, and so forth, but do not include vocalizations. Examples of corpophones at MIM include the rhythmic hand clapping, called *palmas*, in flamenco music (Spain) and the body percussion and chest-slapping in the Maori haka of New Zealand.



**Instrument photos can be printed or turned into flash cards ahead of time. Students can also work with various small musical instruments, if available.*

Divide students into small groups and invite them to list as many different musical instruments as they can on individual Post-it notes. If they don't know the name of an instrument, invite them to briefly describe the instrument instead (e.g., "that brass instrument with the slide that moves in and out"). Invite students to quickly brainstorm as many different ways of grouping, classifying, or organizing these musical instruments as they can, grouping and regrouping the Post-it notes with each new method of organizing musical instruments. Invite one student to record the group's answers to the following questions:

How many different musical instruments can we name (or describe)?

How many ways of classifying or grouping these musical instruments can we come up with?

Examples: according to materials used to make them [the way it was done in ancient China], according to which section of the orchestra they belong, etc.

Are any instruments, cultures, or genres of music not represented in our classification system?

Introduce the term "**organology**" and present the students with the MIM organology flash cards. Encourage students to work together to categorize each of the instruments on the cards. Give them several minutes to work through all the photos. Encourage them to create a list or graph representing the different categories, assigning one person as the recorder.

Why should we classify musical instruments?

Like classifications of animals or anything else, it helps us organize instruments across cultures or geographic locations in a logical way.

What does a universal classification system—such as the one based on how instruments create vibrations—mean for those who study musical instruments and cultures? Why is it helpful?

Universal classification enables us to observe similarities and differences in musical instruments across cultures. For example, one culture's design and use of an aerophone or membranophone may differ from another culture's use of an aerophone or membranophone.

Can a system ever be perfect? Can every instrument be categorized neatly or into one clear category? Why or why not?

Some musical instruments represent a combination of one or more types of instruments. For example, the sound of a chordophone such as the guitar depends heavily on the shape and design of its body, making it similar to an idiophone. Other chordophones combine elements of a membranophone (such as the banjo) in how they produce sound. Generally speaking, Hornbostel-Sachs looks at what originates the sound wave energy but there are always exceptions. Brass instruments, a type of aerophone, initiate their sound with vibration of the human lips, making them similar to a corpophone.

Use the video clips on MIM's YouTube channel (especially the "See It Played" and "From the Collection" playlists) to increase student understanding of different musical instruments.

Extensions

Did anyone come to a different conclusion? Does anyone want to clarify, verify, or challenge that idea? Do you agree or disagree?

What is the history of the Hornbostel-Sachs musical instrument classification system? Has it been altered since it was first developed?

A persuasive writing or research report exercise can be appended here as applicable.

Assessment

Formative

Students will demonstrate their understanding of organology, as well as their understanding of the properties and materials of musical instrument construction through their interaction with their peers.

Summative

Students can explain the history of the Hornbostel-Sachs system of organological classification, the purpose of its development, and the technological innovations that required its alteration.

Tool Kit III
Industrial Design – Imagining New Musical Instruments

Objective
Using their knowledge of the characteristics of sound waves, as well as organology, students will design a musical instrument of their own invention. Students will explain how the instrument will be played, how it will sound, what materials it will be constructed from, and who might play it. They will also identify a potential market for their musical instrument.

Materials
- Pens or pencils
- Post-it notes or similar
- Whiteboard or butcher paper
- Paper for sketching design ideas
- Art supplies for 3-D modeling, such as paper, tape, scissors, paper clips, pipe cleaners, cotton balls, Play-Doh, or Legos
- Computer and access to the Internet for conducting research

Arizona Science Standards Addressed
Strand 3: Science in Personal and Social Perspectives
- Concept 2: Science and Technology in Society

Strand 5: Physical Science
- Concept 1: Properties of Objects and Materials
- Concept 2: Position and Motion of Objects

Strand 1: Inquiry Process
- Concept 1: Observations, Questions, and Hypotheses
- Concept 2: Scientific Testing (Investigating and Modeling)
- Concept 3: Analysis and Conclusions

Background Information for Educators
Industrial design is the process by which many consumer goods, including musical instruments, are developed. A key feature of industrial design is that the design process is conducted separately from the manufacturing process, thus facilitating imagination and creativity without an initial concern for engineering or manufacturing. Industrial design is, by its very nature, interdisciplinary in that the design of an object produces a need to explore other disciplines such as the mechanical or material sciences, engineering, or electronics. In this way, industrial design activities are fruitful starting points for embedded STEM learning.

Students brainstorm new designs for musical instruments.

The Process of Design
Activity 1: Brainstorm
Invite students to spend five minutes individually brainstorming as many new different musical instruments as they can, and to write or draw each new idea on a Post-it note. There is no restriction on what type of musical instrument it might be. As students imagine their new musical instruments, invite them to consider the following questions:

How is your new musical instrument held or played?

How does this instrument produce sound? What vibrates to produce the sound waves? How would an organologist categorize your musical instrument?

What is the inspiration for your musical instrument?

Activity 2: Ask Questions, Explain Ideas, and Organize into Groups

Invite the students to place all their Post-it notes from Activity 1 on a large whiteboard or piece of butcher paper and to spend a moment looking over everyone else's ideas, asking questions and giving explanations to fill in the details of their instrument designs for one another. (In particularly large classes, use additional whiteboards to facilitate discussions among smaller groups of students). Invite the students to begin grouping their musical instrument ideas according to any criteria that they would like, moving the Post-its accordingly. For example, instruments might be grouped by what they're made of or how they're played. They might be grouped using the Hornbostel-Sachs system introduced in Tool Kit II. Once all the instruments have been organized according to some criteria, invite the students to organize themselves into groups based on which musical instrument idea they are most interested in designing further with their classmates.

Activity 3: Model

Invite students to use the art supplies to create a rough 3-D model of their instrument and to refine their discussions of what each different element of the design will do. The 3-D model is not intended to look in any way like the final instrument itself. It exists to provide a physical form to discussions of the different elements and functions of the instrument. For example, a pencil shoved into a crumpled ball of paper wrapped in tape might give physical form to an imagined guitar-like instrument.

Students model and create prototypes of musical instruments.

Activity 4: Sketch and Present

Invite students to work as a group to sketch a design proposal for their instrument. For younger students, this activity can take on the spirit of a group art project followed by a presentation. For older students, the complexity and detail of the proposal can increase in whatever way might be most developmentally appropriate for the specific group of students.

Students share their design ideas with one another.

A typical design proposal might include the following:

1. A detailed drawing or schematic of the musical instrument
2. The function of all the different elements of the musical instrument
3. The materials the instrument will be built out of and their associated costs
4. The intended market for the musical instrument, including examples of any similar instruments
5. The specialized skills or manufacturing processes that might be required to build the design (e.g., metalworking, electrical engineering, woodworking, painting, 3-D printing, computer programming, etc.)

Extensions

MIM's advanced curriculum for "STEM: How Science Brings Music to Life" begins with activities that explore acoustic amplification (i.e., resonance), electronic amplification, and electronic oscillation.

Advanced modeling techniques can be used to create a prototype of the instrument itself using inexpensive materials such as Play-Doh, PVC pipes, rubber bands, tape, carved Styrofoam, etc.

Autodesk is a company that produces a suite of design programs used by professional designers worldwide, many of which are available to students for free. Autodesk's Tinkercad program is designed to help young children design and print their own creations in 3-D.

Assessment

Formative

Students will demonstrate their understanding of the physical properties of the materials, the uses of various kinds of technology in society, and the process of scientific inquiry as they work with peers to develop, design, model, and sketch their musical instruments.

Summative

The formal design proposal provides an organic opportunity for summative assessment of basic student understanding of material properties and physical motion, as well as the use of technology in society.