MATON GUITARS MODULE

LEARNING RESOURCES KIT

AUSTRALIAN MUSIC VAULT

MATON GUITARS MODULE

Victorian Curriculum Links

Learning Areas	Capabilities
The Arts - Music o Respond & Interpret	Critical and Creative Thinking - Questions & Possibilities

English
- Speaking and Listening
  o Language
  o Literacy	

Science
- Science Understanding
  o Science as human endeavour
  o Physical sciences	

Technologies
- Design and Technologies
  o Technologies & Society
  o Technologies Context	

The Maton factory floor. Image courtesy of Maton Guitars.

MATON GUITARS - PRE-VISIT

OVERVIEW

Musical instruments play a very important part in rock music, and indeed all genres of music. Instrument making is an art, and the Australian guitar making company, Maton, started in 1946 by Bill May, certainly still view it this way. Maton see a guitar as an extension of the musician who owns it, they need to understand and love the guitar, and even sometimes participate in its design. Each Maton guitar is handmade from Australian wood, and they have a unique tone, much loved around the world.

CONTEMPLATE AND DISCOVER

- **"I watched it slowly become my guitar and I fell in love with it even before I played it."** This is a quote from Graham Russell from Australian band Air Supply. Talk in a group about what he may have meant, and how this feeling could have come about.
- **Musicians often talk about the different feelings and personalities of their instruments.** Watch this video of singer/songwriter Josh Pyke talking about his Maton guitar. What do you think gives a guitar (or any other instrument) its personality? What do you think it means when a musician says their instrument has a soul? (Check out the sound of a Maton Messiah here, and the full video clip involving Josh Pyke in the Maton guitar boat here.)
- **Without looking at a picture of a guitar, think about the first guitar to come into your mind.** What shape does it have? Guitars come in all shapes and sizes, and popular shapes have changed over the years. Brainstorm about what the shape of a guitar means aesthetically and also how it could influence the sound of the instrument.

A variety of guitar shapes

- **Check out the anatomy of both an acoustic and electric guitar.** What parts do they have in common and which are unique to one type of guitar or other? For more information, see here or here.

The parts of an acoustic and electric guitar.

- **Brainstorm things that you as a musician would want in an instrument.** What would make you love one instrument over another, try to think of everything that might influence your choice.
- **If you were to design a whole new instrument, what would it be?** Describe the sound in a paragraph and make a quick sketch of what the instrument would look like.

REFLECTIONS

A musician's instrument is one of the most important items in their life. It contributes to their sound, their look, their persona, and often spends more time with them than their family and friends. Quite often a musician will have several instruments and they can chart moments in their life by the instrument they had at the time. Sometimes musicians contribute to the development of an instrument or modify it in a way unique to them. It is for these reasons that it is interesting to collect and display instruments owned and played by musicians in exhibitions and museums. We can hear those instruments in recordings, but we can also see them, their modifications, their wear and tear, and perhaps even see the signs of love accumulated during their lives.

TASK 1 – HOW TO BUILD A GUITAR

CHOOSING YOUR WOOD

Australian tone woods, used for the body of Maton guitars. Image courtesy of Maton

Maton are well known for their use of Australian tone woods to shape the body of their guitars. They use locally sourced wood wherever possible. The Blackwood comes from the forests in the Otway ranges. The woodsman picks out 'guitar trees', ones that are towards the end of their life. He cuts them into guitar sized pieces on the forest floor and carries them out one by one.

BODY WOODS

Queensland Maple	Queensland rainforest hardwood light and strong, beautiful.	Sweet tones, upper-mid and top end sound ranges
Victorian Blackwood	Cut in Victoria's Otway ranges	Warm tones in the middle sound ranges
Tasmanian and Queensland Sassafras		Ideal tonewood for a bass guitar

Did you know? Maton specialise in making guitars from Australian timbers such as Blackwood, Bunya, Pine, Queensland Maple and Mulga which are chosen for their natural tonal qualities.

DEHYDRATION

Before the wood can be shaped, it needs to be dehydrated so that it doesn't expand and contract from residual moisture. Maton has two large rooms, essentially giant microwaves with different humidity levels. The wood is first exposed to high humidity, before being left to rest on the factory floor at room temperature. This allows the wood to 'cure' (dry out). Dehydrating the wood can take between 8 weeks and 8 months but is very important – if this isn't done properly the wood can shrink and expand, making it impossible to keep the guitar in tune.

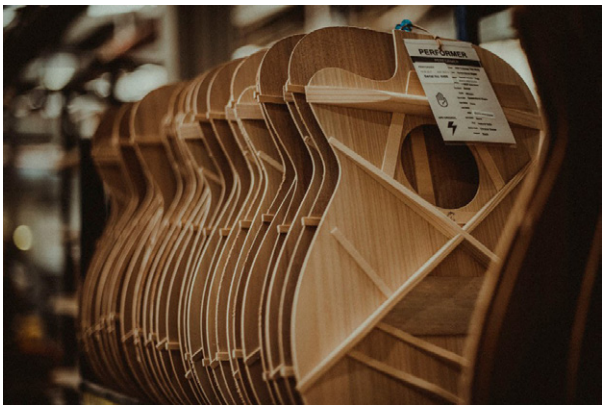
MAKING THE PARTS

The first step in the process of making a guitar is cutting timber down to 'blanks' – smaller pieces of wood shaped into the component parts of the guitar. These parts are the two face and back plates, the curved sides and the neck.

Neck Blanks at the Maton Factory.
Image courtesy of Maton.

Back: When cutting the wood for the back of the guitar, the luthiers cut the wood down the middle and open it like a book – this is so that the sound vibrates evenly and the patterns in the wood are mirrored.

Face: Crossed wood is attached to the face of the guitar – this bracing helps to provide both structural and tonal integrity to the instrument.



Body Blanks at the Maton Factory. Image courtesy of Maton.

Sides: The sides need to be bent into shape before they are attached. They first have a quick hot bath to make the wood easier to bend, and then are put into a press that is shaped to the sides of a guitar. The wood is heated for 10 minutes while the water evaporates. When the wood comes out of the press it is ready to be attached to the other pieces.

Side blanks for Maton guitars at the factory. Image courtesy of Maton.

Side blanks for Maton guitars at the factory. Image courtesy of Maton.

Did you know? This method of bending the wood has been done the same way since Bill May started making guitars in 1932.

BUILDING THE GUITAR

To build the body of the guitar, the guitar makers use a 'jig'. Jigs are big frames that are shaped like guitars. All the pieces are glued together and clamped into the right shape to dry.

Jigs being used to build the body of a Maton guitar. Image courtesy of Maton guitars.

Once they are dry, the guitars are carefully sanded. To make sure they are perfect, the guitar makers put them under a special UV light to pick up imperfections that can't be seen in normal light.

Sanding the guitar body in the Maton factory. Image courtesy of Maton.

The neck of a guitar is attached using a special kind of join, called a 'dovetail.' The wood is cut like two edges of a puzzle piece and then locked together.

The process of attaching the neck of the guitar. Image courtesy of Maton.

They paint the guitar with a special kind of paint, called lacquer, which dries into a hard and shiny coat.

A fretboard, the part of the guitar where a guitarist presses the strings to play different notes, is then glued to the neck.

Fret boards stored at the Maton factory. Image courtesy of Maton.

They then attach the bridge, the part where the bottom of the strings are tied and the guitar is strung and ready to play.

Bridges stored at the Maton factory. Image courtesy of Maton.

To see the Maton Factory, check out any of the following videos.

- Maton Guitars YouTube Channel – Introductory video
- Part 1 (Wood Storage) – Part 15 (Set up) videos from Maton (others listed here)
- Cranbourne Music Maton Factory Tour

Before visiting the Australian Music Vault, listen to the following playlist to hear songs performed by artists who use Maton Guitars, both electric and acoustic. As a class listen to one a day and discuss.

Here are some examples of questions you can discuss.

- What style of music is it?
- What instruments can you hear?
- What themes or issues do the lyrics explore?
- What social and historical significance might this song have?
- What is the mood or feeling it creates?

Listen to the Maton Guitars playlist on Spotify

Fire and the Flood by Vance Joy

Fire and the Flood was released by Australian songwriter Vance Joy in 2015. He wrote and recorded the song whilst on tour to promote his debut album Dream Your Life Away and the track was subsequently included on the deluxe edition of the same album.

"I had a recurring image in my head of a guy walking in the neighbourhood where his ex-girlfriend lives," he says of the song. "He is haunting the places they used to go together. He has time on his hands and feels kind of useless. He thinks that when they are back together he'll be at peace again." The song showcases Vance Joy's emotion-filled vocals with acoustic guitar and the epic sounds of horns and drums.

Tip of My Tongue by Diesel

Mark "Diesel" Lizotte began his musical career playing with *Johnny Diesel and the Injectors*. The band was named as a joke after a mispronounciation of John Dalzell – their bass player's name. The name stuck and Diesel became a moniker for Lizotte's work as he continued to release albums and tour across three decades. *Tip of My Tongue* was released in 1992, taken from the album *Hepfidelity*. In 1993 the album received the ARIA award for Best Album, Diesel received the award for Best Male Artist and the song itself was nominated for Single of the Year. Diesel continues to release albums and tour, celebrating 30 years of his musical career in 2018.

The Sound of Sunshine by Michael Franti

Michael Franti is an American musician, singer-songwriter and hip hop artist known for his participation in musical projects such as *The Beatnigs*, Disposable Heroes of *Hiphoprisy* and his independent project *Michael Franti* and Spearhead. Speaking of the political and social emphasis in his work Franti has said "I'm not so interested in politics as I am in ways that people make a difference in the world."

The Sound of Sunshine is the title track from the album of the same name released in 2010. It was written following a ruptured appendix and hospitalisation, "It was like I was seeing everything with new eyes. Every day I'd go to the window to see if the sun was shining - and if it was, I'd have this feeling of optimism!" Franti has said of the track "These days there is much to worry about. The economy, climate change, war or just making it through a rough day. 'The Sound of Sunshine' is a song about the sun's ability to make any day better."

On My Side by Gordi

Gordi is the moniker for Sydney based Australian folktronica singer/songwriter Sophie Payten, a name that originated as a family nickname given to her by her older brother. Growing up on a farm in rural Australia, she filled the space around her with music, continuing to write and release music whilst completing a medical degree. The single *On My Side* is taken from her album *Reservoir* released in 2017.

The track deals with needing support, but not wanting to ask for it, "I wrote this song about wanting to tell someone that I needed them to ask me how I was, but for some reason, I couldn't do it" Payten says about the track. "I couldn't ask them to be there for me, I just wanted them to do it without my invitation." The song poured out in 45 minutes and the finished track features guitar strums and raw, reflective lyrics.

Anything Can Happen by The Finn Brothers

The track *Anything can happen* is taken from the Finn Brothers' album Everyone is Here, released in 2004. Although Neil and Tim Finn had worked together in Split Enz and Crowded House, Everyone is Here was their second release as a duo. Speaking about the songwriting on this record Tim Finn has said "it was the first time we really channelled the theme of family, of us being brothers, and used it through the album." Written during the period of their mother's battle with cancer, Neil Finn has said she is "an all-pervasive but not explicit presence" on the album, but she passed away before it was released. The album was recorded twice, with recordings from both recording sessions being released at various times. *Anything Can Happen* is an upbeat guitar pop song written with the trademark crafting that has made the Finn brothers internationally renowned masters of songwriting.

Blues in My Heart by Fiona Boyes

Fiona Boyes' career as a blues artist began after winning a Maton guitar in a local coffee shop talent show. Since then she has received many accolades and awards, touring Australia and internationally for more than 25 years. During the early years she honed her skills in an all female band, The Mojos, who released five recordings together.

Blues in my Heart is taken from Fiona Boyes first solo album of the same title, released in 2000. It showcases Boyes' laidback acoustic fingerpicking style and husky blues voice.

The Summer by Josh Pyke

During his career as a singer-songwriter Josh Pyke has released five acclaimed top 10 albums, and received 4 ARIA awards. Known for his ability to bring together strong, poetic lyrics with crafted pop hooks, Pyke first came to national attention in 2015 with his EP *Feeding the Wolves.*

The Summer is taken from the album *Chimney's Afire,* released in 2008. Speaking of the impetus of the song Pyke has said "That song is almost about reminding yourself to live life like the way you experienced when you were falling in love and when you're a kid."

Overkill by Colin Hay (Acoustic Version)

Colin Hay rose to fame as the front man of the iconic Australian band *Men at Work.* The band formed in 1979 and skyrocketed to success in the early 80s with their debut album Business as Usual and their single *Land Down Under.* Despite their rise to fame during this period Colin Hay says that it wasn't until he penned Overkill that he had written a song that he was happy with. The song was taken from Cargo, Men at Work's second studio album, released in 1983. Speaking about the song Hay has said "I like "Overkill" for a few different reasons. When you first start writing you think to yourself "Am I any good at this?" and you keep on going. "Overkill" was the first song where I felt I was getting anywhere, so that's a special song for me."

When *Men at Work* disbanded in 1985 Colin Hay launched a solo career to fluctuating success as he struggled to focus himself in the aftermath of his pop success. He re-established himself as a touring artist, releasing several solo albums. In 2002 Colin Hay appeared in the comedy medical drama *Scrubs* performing *Overkill* as part of an episode.

April Sun in Cuba by Dragon

Dragon formed in New Zealand in 1972, deciding in 1975 to relocate to Australia to reach a bigger audience. They were inducted into the ARIA Hall of Fame in 2008 following a career sometimes marked by tragedy, adversity and notoriety. They were regular on the TV pop show Countdown, and frontman Marc Hunter hosted the show several times.

April Sun in Cuba was written by the late Dragon keyboard player *Paul Hewson* and later added to by Marc Hunter. "We recorded April Sun in Melbourne in early 1977," says Todd. "The band had had a bad car accident that was a very close call for Robert Taylor and Paul Hewson. When we were recording the back track, I distinctly remember looking around the studio and thinking we were a bunch of bedraggled, bandaged and neck-braced casualties recording this bright and shiny pop song." The song appeared on their fourth studio album *Running Free.*

All Out of Love by Air Supply

Air Supply are an Australian duo consisting of Graham Russell and Russell Hitchcock who met in 1975 while performing the Australian production of Jesus Christ Superstar. After the shows they would play coffee bars and pizza parlors with one guitar and two voices, gaining attention for their great harmonies and original songs.

All Out of Love was taken from the album *Lost in Love,* released in Australia in 1978. Written by Graham Russell, the original lyrics were *"I'm all out of love, I want to arrest you"*. However when the album was released internationally in 1980, producer Clive Davis found the lyrics confusing and changed them to *"I'm all out of love, I'm so lost without you"*. The song was a hit in America and the UK.

DURING THE VISIT

LOOK

Look out for the custom made guitars in the exhibition, for example the prototype Mini Maton EMD-6 made for musician Mark Lizotte (Diesel). He loved Maton guitars, but also played smaller bodied guitars which Maton didn't make, so he worked with their luthier, Andy Allen, to design the Mini Maton. The Mini Maton is now played by many other musicians including Courtney Barnett. Tommy Emmanuel was another musician to work with Maton to customise guitars, in particular their pickups, the part of the guitar that allows the guitar to be plugged into a PA system to amplify the sound.

LISTEN

Listen to the songs available for playback on the digital labels. See if you can hear the guitar sound in the mix and identify its tone. Is it bright, prominent, muted, sweet? Think of words you could use to describe the guitar tone. Different Maton guitars have different tones, but they are known in general to have a rich, full-bodied sound with good projection.

INVESTIGATE

Look for examples where the musician has collaborated with Maton on the design of their particular guitar. This collaboration allows guitars to be crafted that perfectly suit a particular musician, and also helps instrument designers and makers innovate and develop their designs over time.

The Maton Exhibition at the Australian Music Vault, 2018.

POST VISIT

PROJECT 1 – INSTRUMENT MAKING

Designing and making your own instrument can be a lot of fun. You need to take into account what it will look like and what it will sound like! Some instruments are beautifully designed, whereas others are more functional, they sound great, but might not look amazing.

Neustadt Kunsthofpassage in Dresden, Germany. A multi-story musical instrument designed by Cristoph Roßner, Annette Paul, and Andre Tempel

LISTEN

There are lots of different types of instruments you can make, some are listed below and the questions underneath will greatly affect the sound the instrument makes –

- **Instruments to bang on or bang together**
    - Material/size/shape?
    - What do you hit it with?
- **Instruments to blow into**
    - Material/shape?
    - How long?
    - Are there holes? (Take note what closing and opening the holes do)
- **Instruments to shake**
    - Material?
    - What is inside? How much of the material is inside?
- **Instruments to pluck**
    - Material of the strings / bands?
    - Is there a sound hole to amplify the sound? (ie. the guitar body)

Draw your instrument first, labelling the parts. Try drawing it from different angles so you can see how to make it. Have a guess at what it will sound like before you make it. You may like to design a brand for your instrument, or perhaps a brand across a few people's different instruments. Draw a logo that you feel sums up your instrument brand. Is it colourful, bold, smooth, jagged, challenging?

Homemade harp.

If you need inspiration, here are some sites that could get you started –

- 14 Handmade Instruments That Actually Play Music
- 42 Splendidly Creative Homemade Musical Instruments

Homemade French Horn made from pipe and a funnel

Advanced –

- Could you add amplification to this instrument? Either a pickup or a microphone on the body of, or nearby the instrument.
- Check out MaKey MaKey kits – they are fantastic to use to make innovative instruments from anything that conducts electricity

TASK 2 – MUSICIAN/INSTRUMENT SPOTLIGHT

There are most likely many musicians in your local community with fantastic stories about their instruments and why they are special.

Sophie Koh at Port Fairy Folk Festival 2018. Photo by David Harris.

Start by sourcing the musician you will talk to. Perhaps you will go out in groups from your class, or bring in a musician to talk to the whole group. Do some research about the style of music they play, whether it's country, rock, pop, classical or jazz. Ask them politely if they could bring their instrument (or instruments!) on the day and have them ready to show you and to demonstrate.

Prepare some questions for the musician, specifically about their instrument. Think of open questions or statements that begin with What, How or Tell me about… If an answer to a question makes you think of another question, ask it! This is called a follow-up question. Write up to 10 questions, some ones to get you started are -

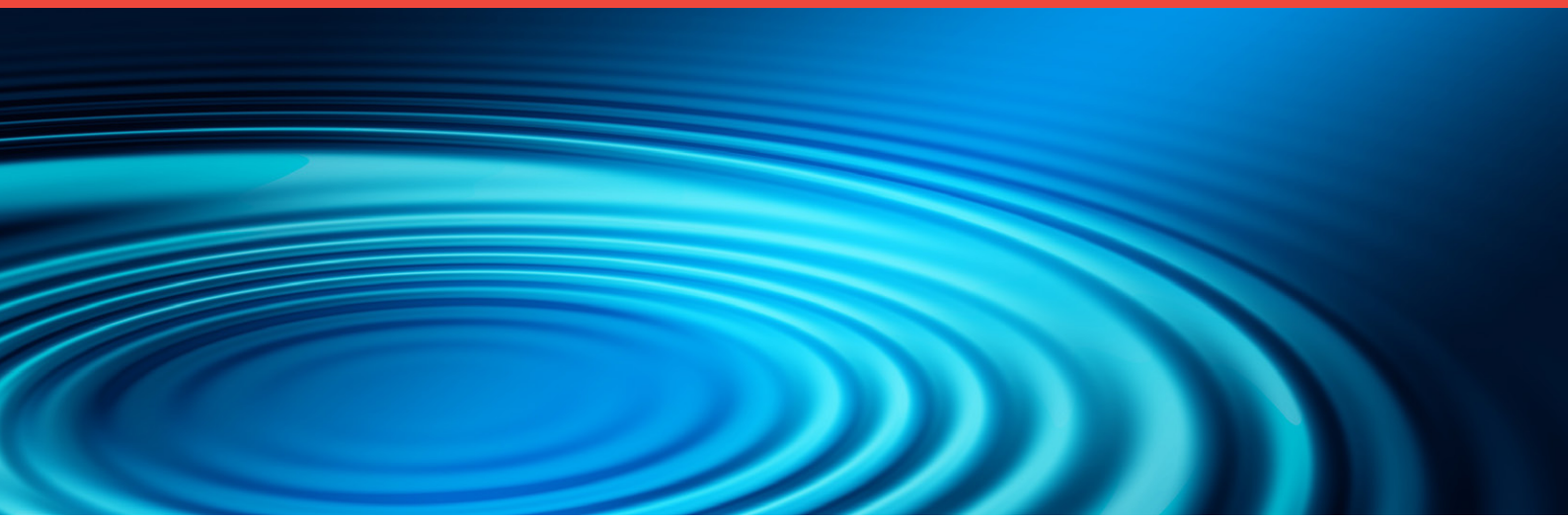
- What is special to you about your instrument?
- How did you come about owning your instrument?

It would be really interesting to ask the musician to play their instrument after you've asked them the questions, or perhaps even during the interview. Try asking them to play it in different ways, for example individual notes, long, short, high or low notes, chords (if possible) or whole pieces. Perhaps they have a few similar instruments (ie. different guitar brands or a flute and a piccolo) and you could contrast the sounds.

It would be great to record the interview and instrument performance. You could use a mobile phone, a video camera, a computer microphone or any other type of microphone. Then after the interview you could edit the sound you've recorded in a free program such as Garageband or Audacity and make a radio program or podcast. The recording doesn't have to be very high quality, for example here's an example of Melbourne musician Phia demonstrating the kalimba for a radio program.

Take some photos of the musician and their instrument, don't forget to always ask permission! Put the background research, recording and images together into an AV presentation for your class or other relevant audience.

Singer/songwriter Emily Wurramara. Photo by Lachie Millard.



STAND ALONE

PROJECT 1 – THE SCIENCE OF SOUND AND GUITAR STRINGS

SOUND

- Sounds are vibrations of the air caused by a vibrating source
- "Any sound, whatever it may be, is caused by something vibrating. In other words, by something which is moving back and forth, either in a regular manner or in a random manner, about the position it occupies when at rest. The source of the sound may be a car engine, a burglar alarm or a bird singing. Whatever it is, some part of it must be vibrating for it to produce sound". [Quote source]

TRY: Feel the sound

- Hum with a finger on your throat to feel your voice box vibrating

VIBRATION

- Vibration is an oscillation (back and forth movement) of air pressure caused by vibrating objects

ENERGY

- If you exert force on a string – potential energy is transferred into kinetic energy as the string moves back and forth until it comes to rest in potential energy again

WATCH: Simple Harmonic Motion

TRY: See and feel vibration

- Pluck a guitar – see how strings move back and forth
- Hit a drum with beads sitting on its surface – watch the energy of tone causing the beads to move
- Hit a drum and touch its skin – feel the vibration through your hand
- Hit a tuning fork on a table and then place near a container of water – watch how the vibration of the fork moves the water
- Cup and string activity – notice how the sound travels down the string to your ear [Lesson Plan]
- Play a kazoo – notice how your voice causes the membrane to vibrate and make a buzz

WATCH: Sound Crash Course

HEARING

- "When we hear a sound, what our ears are actually doing is converting the rapid fluctuations in air pressure that make up a sound wave into neural impulses. The human ear comprises three fairly distinct sections; the outer ear, the middle ear and the inner ear". [Quote source]

- Sound is also felt in the body

WATCH: Touch the Sound

Touch the Sound is a documentary about Dame Evelyn Elizabeth Ann Glennie, a Scottish virtuoso percussionist. She has been profoundly deaf since the age of 12 and taught herself to hear with parts of her body other than her ears

SOUND TRAVEL

- Sound needs a medium to travel through from the source of the sound to the ear in the form of a gas, solid or liquid
- Sound travels faster in water than in air (the particles in liquid are closer together and so allow a quicker transference of their energy)
- "The vibrations of a sound source cause the neighbouring air molecules to be alternately squeezed together and pulled apart. These air molecules then push and pull against their neighbours which, in turn, push and pull against their neighbours. In this way, a series of compressions (regions of higher pressure) and rarefactions (regions of lower pressure) is generated which travels away from the vibrating source. This sequence of pressure fluctuations is what we refer to as a sound wave". [Quote source]

TRY: Air pressure with a slinky or rope

- In pairs, each hold one end of an outstretched slinky
- One person holds the end steady, the other person pushes the slinky towards their partner (this will be easier if the slinky is resting on a surface such as a desk or the floor)
- This movement will cause a compression and rarefaction of the slinky as the energy is transferred along the slinky until it reaches the other person
- This is a visual demonstration of how air particles are moved when excited by energy such as vibration (this can be explained as the sound being made at one end - with vibrations that disrupt air particles until the sound reaches the ear at the other end)

WATCH: Sound wave motion animation

- Look at how this slinky soundwave example looks at a molecular level. This is also what a sound wave looks like (formed by high and low air pressure moving through time)

WATCH: Vibrating guitar strings

- Look at how each string is vibrating – the shape the string is making is also its corresponding waveform

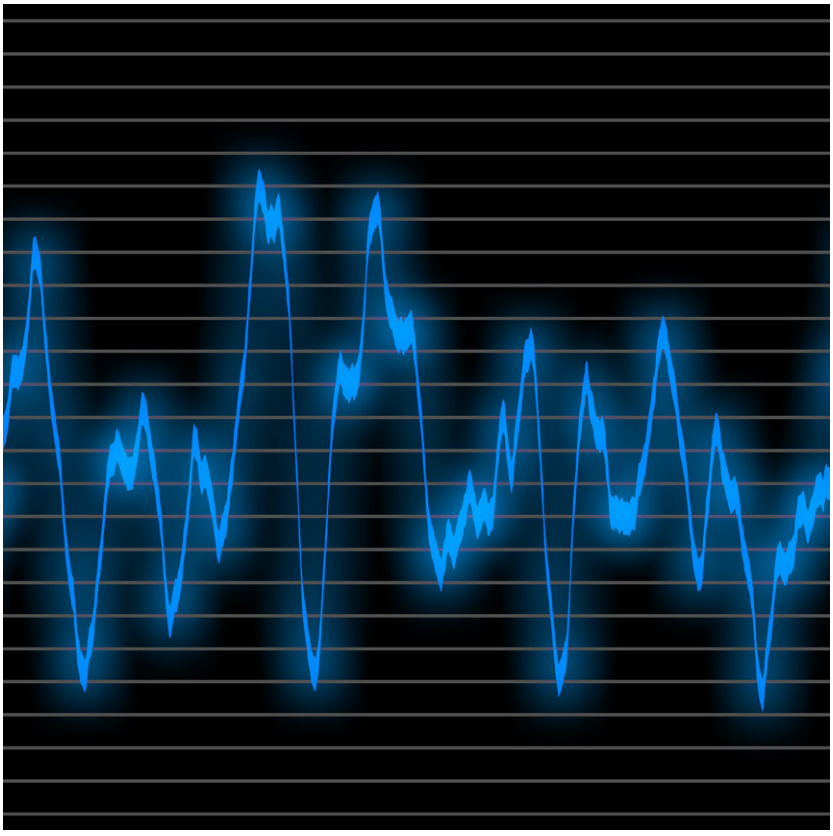
SPEED OF SOUND

- The speed of sound is a constant and allows us to measure how many waves are occurring as they reach our ears
- The speed of sound depends on the state of the gas – on Earth the atmosphere is composed of mostly nitrogen and oxygen and the temperature depends on the altitude
- At sea level at 21 degrees and normal atmosphere the speed of sound is 344 meters per second

PITCH/FREQUENCY

- Guitar example: because the speed of sound is constant – if you could count how many sound waves reach you per second – you would know how many times the string vibrates (moves back and forth) in a second – this number is called the sounds pitch or frequency – the rate at which the waves pass a given point and the rate at which a guitar string or a loudspeaker vibrates

WATCH: Sound Waves

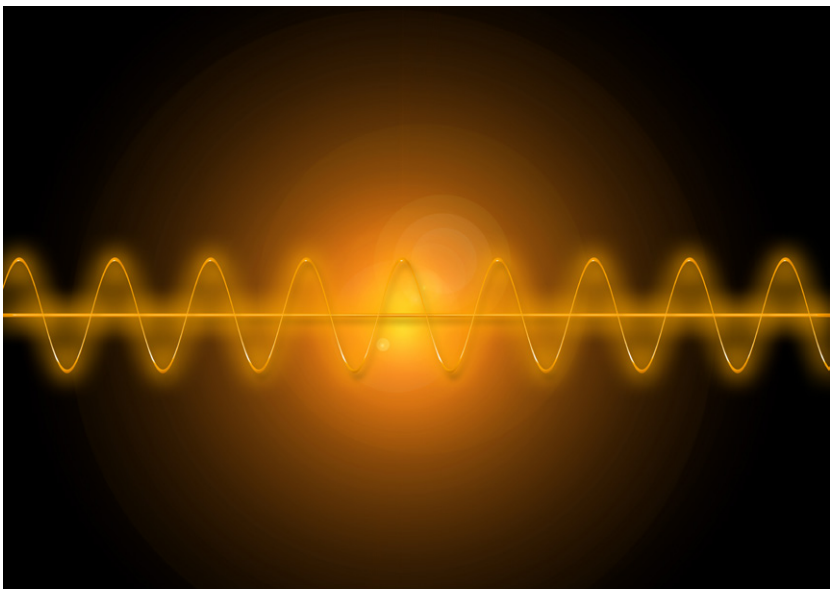


TRY: Ruler and pitch activity

- Hold a ruler flat on a table with some length of the ruler hanging over the edge
- Hit the end that is hanging over the edge and notice the pitch it makes
- Pull more or less of the ruler over the edge and hit this end again
- Notice how the length of the vibrating section of the ruler effects the pitch of the sound
- The more the vibrating ruler is over the edge of the desk, the lower the pitch

WAVELENGTH

- A wavelength is the distance between two troughs or peaks of a wave
- Wavelengths are measured in Hertz



TRY: Chrome Music lab sound waves activity

- Click a note on the keyboard to hear the note and see how the air particles are displaced
- Click on the magnifying glass to see the sounds corresponding wavelength
- Try playing low and high notes and notice the difference in the wavelength

TRY: Online vibration activity

- Look at the vibration speed and intensity of a sound:
- The vibration speed is the frequency and the vibration intensity is the amplitude
- Notice – the more air is moved, the larger the waveform and the louder the sound
- Notice – the faster the air is moved, the closer together the waveform and the higher the sound

TRY: Frequency and amplitude with a slinky or rope

- In pairs, each hold one end of an outstretched slinky or rope – rest the slinky on a surface such as a desk or floor
- One person hold the end steady, the other person oscillate the rope up and down slowly and then quickly – this will demonstrate the frequency or rate of oscillation of the rope
- Try again but this time one person keeps the frequency the same but changes the amount of energy passes through the rope – this will demonstrate the changing amplitude of the rope

NATURAL FREQUENCY

- "The frequency or frequencies at which an object tends to vibrate with when hit, struck, plucked, strummed or somehow disturbed is known as the natural frequency of the object". [Quote source]

TRY: Frequency of strings

- Make a string experiment with a box, rubber bands and bridge (you can use pencils for the bridge)
- Move the bridge to demonstrate how the length of a string determines the frequency of the sound produced
- String Experiment
- Build a guitar

TRY: Chrome Music Lab – Strings

- "This experiment lets you explore the natural mathematical relationship between a strings length and its pitch. For example, the second string is half the length of the first, and it plays the same note an octave higher."

GUITAR STRING FREQUENCY

- Factors effecting the frequency of guitar strings are length, tension, density and thickness
- "A guitar has six strings, each having a different linear density (the wider strings are more dense on a per meter basis), a different tension (which is controllable by the guitarist), and a different length (also controllable by the guitarist). The speed at which waves move through the strings is dependent upon the properties of the medium - in this case the tightness (tension) of the string and the linear density of the strings. Changes in these properties would affect the natural frequency of the particular string. The vibrating portion of a particular string can be shortened by pressing the string against one of the frets on the neck of the guitar. This modification in the length of the string would affect the wavelength of the wave and in turn the natural frequency at which a particular string vibrates at. Controlling the speed and the wavelength in this manner allows a guitarist to control the natural frequencies of the vibrating object (a string) and thus produce the intended musical sounds". [Quote source]

TRY: String Experiment

- Use the string experiment with a box, rubber bands and bridge again
- This time use rubber bands with different thicknesses to demonstrate how the strings thickness effects the frequency produced
- Also try tightening the rubber band to demonstrate that the tension of the string also effects the frequency produced

EXTENSION FOR LOWER SECONDARY

STANDING WAVES

- "A standing wave is the pattern produced in a medium as the result of the repeated interference of two identical waves moving in opposite directions through the medium. All standing wave patterns have nodes and antinodes. The nodes are points of no displacement caused by the destructive interference of the two waves. The antinodes result from the constructive interference of the two waves and thus undergo maximum displacement from the rest position.

- Antinodes: The points in a standing wave with maximum displacement from the resting position. The antinodes result from the constructive interference of the two waves. This means the waves are in phase and the combination of their energy moves the medium the greatest distance from its resting position. Nodes: The points in a standing wave with no displacement.
- Nodes result from the destructive interference of the two waves. This means the waves are out of phase (one wave moves up and the other wave moves down) and the combination of their energy is zero. Thus the medium doesn't move at all". [Quote source]
- "The pattern above is not the only pattern of vibration for a guitar string. There are a variety of patterns by which the guitar string could naturally vibrate. Each pattern is associated with one of the natural frequencies of the guitar strings. Each standing wave pattern is referred to as a harmonic of the instrument". [Quote source]

TRY: Chrome Music Lab - Harmonics

- "The harmonic series is a set of frequencies with a simple relationship: twice as fast, three times as fast, four times, and so on. Musical intervals emerge from this natural phenomenon, such as the octave and the major chord"

TRY: Standing waves with a slinky

- In pairs, each person hold one end of an outstretched slinky or rope
- One person hold the end steady, the other person oscillates the rope up and down slowly to produce the fundamental 1st harmonic
- Try this again now increasing the vibration to produce the 2nd harmonic and continue to attempt to produce 3rd and 4th harmonics

WATCH: Online demonstration of slinky activity

WATCH: The physics of playing guitar

TRY: Open-string and fretted harmonics lesson

RESONANCE

- "If you were to take a guitar string and stretch it to a given length and a given tightness and have a friend pluck it, you would hear a noise; but the noise would not even be close in comparison to the loudness produced by an acoustic guitar. On the other hand, if the string is attached to the sound box of the guitar, the vibrating string is capable of forcing the sound box into vibrating at that same natural frequency. The sound box in turn forces air particles inside the box into vibrational motion at the same natural frequency as the string. The entire system (string, guitar, and enclosed air) begins vibrating and forces surrounding air particles into vibrational motion. The tendency of one object to force another adjoining or interconnected object into vibrational motion is referred to as a forced vibration. In the case of the guitar string mounted to the sound box, the fact that the surface area of the sound box is greater than the surface area of the string means that more surrounding air particles will be forced into vibration. This causes an increase in the amplitude and thus loudness of the sound". [Quote source]
- "This is an example of resonance - when one object vibrating at the same natural frequency of a second object forces that second object into vibrational motion." [Quote source]

TRY: Resonance activity

- Place rubber bands over containers of varying sizes to demonstrate how different sized resonating chambers amplify more or less and what area of the frequency spectrum they amplify more or less
- This can be done with a tuning fork as well – hit the tuning fork with a rubber mallet and notice the amplitude of the fork. Try this again but rest the tuning fork on a desk or window or whiteboard – the amplitude will be greater as the tuning fork forces the surrounding surface particles into vibrational motion. The surface will force the surrounding air particles into vibration and so the amplitude of the sound will be increased

Further reading on guitar acoustics