Contents

TE MANAWA MUSEUMS TRUST, 326 Main Street, Palmerston North

INTRODUCTION

Developed at Te Manawa, *Sounds Amazing* is a hands-on exhibition exploring how and why sound is made.

ABOUT THE EXHIBITION

Learn about the science of sound and how music is made. Explore how sound is created and measured, how it travels, and the technology of sound manipulation. How do musicians get different notes from their string, wind or percussion instruments? Find out by strumming the giant harps, striking the gamelans, playing the slap-a-phone (bongo pipes), or tickling the ivories of the giant keyboard. Investigate whether sound can travel in a vacuum, produce a transverse wave pattern and a longitudinal wave pattern in a string and spring and manipulate laser generated wave patterns to create shapes.

ABOUT THE EDUCATION PROGRAMME

The Sounds Amazing Education programme is suitable for Year 3 – Year 11 and takes 1 1/2 hours, which may be shortened for younger students
After a brief introduction, students will explore the exhibition in small groups followed by an educator-led activity.

Special Requirements:

Some prior knowledge of students' level of understanding within this subject area would be appreciated, and can be provided by filling out our pre-visit questionnaire. This will mean that your students' specific learning needs will be better catered for.

CURRICULUM LINKS

Science
Nature of Science Level 1 – 4
Investigating in science.
Communicating in science.

Physical World
<u>Physical Inquiry and Physics Concepts Level 1 - 4</u>
Explore everyday examples of physical phenomena, such as sound and waves (Level 1 – 2).
Explore, describe, and represent patterns and trends for everyday examples of physical phenomena, such as sound and waves (Level 3 – 4).

The Arts
Music – Sound Arts Level 1 - 3
<u>Developing practical knowledge</u>
Explore and identify how sound is made and changed (Level 1 – 3).

<u>Key Competencies</u>

Using language, symbols and texts
Students will learn and become familiar with the specialist language (including symbols and text) associated with the topic.

Thinking
Students will use creative, critical, metacognitive, and reflective processes to make sense of and question information, experiences and ideas.

Learning Intentions

We are learning to:

- Follow instructions carefully
- Make observations about the properties of sound
- Understand that sound occurs when an object vibrates (moves back and forth quickly)

We know we have achieved this when we can:

- Make an exhibit work as designed
- We can describe and provide examples of important properties of sound
- We can observe vibrations creating sound

NCEA Achievement Standards

Science
Physical World

3.6 Describe selected properties and applications of EMR, radioactive decay, **sound** and ultrasound.

Pre and Post Visit Activities

- Singing balloons. To find out how your vocal cords work, blow up a balloon and stretch the neck sideways as you let the air out. What happens as you stretch the neck in and out?

- What sound is that? How is it made? We live in a world of vibrations. Vibrations make sound. Have students sit quietly for 5 minutes and record all the sounds they can hear. Try and figure out what might have been vibrating to make the sounds.

- Look at a guitar, violin or cello. Investigate how each string is attached and how the string can be manipulated. What effect does this have on the sound the instrument makes?

- Find out about Māori musical instruments. Are there any differences or similarities in the materials used in traditional and modern instruments? Or in the way they are played?

- Use a slinky spring to investigate waves. Or attach a thick rope firmly to a wall (or other immoveable object) and use it to generate and explore wave patterns.

- How fast does sound travel? How fast does light travel? Does sound travel at different speeds at different altitudes and different temperatures or in different materials? Investigate through the internet.

- Listening to balloons. Blow up a balloon and tie the end. Hold a ticking clock against the balloon and listen to it with your ear against the opposite side of the balloon. Now try listening to the clock using a balloon full of water. What difference do you notice? You could try a balloon filled with helium instead of air.

- Yoghurt pot phone. Make a small hole in the bottom of 2 empty, clean yoghurt pots then thread the ends of a long, thin piece of string through the holes and knot inside the pots. Try 3m of string to start with and then experiment with different lengths. While someone listens with their ear to one pot, another person can talk into the other pot. Does it work better if the string is really tight or really loose? Experiment with different types of string and containers.

- Sound charades. Make a number of cards with words like: happy, sad, hungry, frightened, hurt, warning. Have one person stand in front of the group with their back to the class so their facial expressions can't be seen. Give this person a card – they must make a sound to illustrate the word and the rest of the group must guess what the word is.

- Big ears. Use thin card to make cones of different sizes and hold them up to your ear one at a time – do any of them help you hear better? Try making some other shapes and test them. Find some pictures of animals with unusual ears – how do you think they help the animal?

- Ear bits. Draw individual parts of the ear on A4 pieces of paper. Pin the pictures on the backs of some students. Each person with a picture on their back must now find out what the picture is by asking others to describe it.

- Ask someone who is deaf or hearing impaired or who works with deaf or hearing impaired people to visit, and learn how to communicate.
- Find out how a hearing aid works. Investigate any differences between old and new hearing aid technology.
- Sea shells, sea sounds. Find out why you seem to hear the sea when you put your ear to a seashell. Does the same happen when you listen to other closed tubes?
- What sorts of things can go wrong with our ears and hearing? What causes these defects?
- Investigate how animals hear? Do they hear as well as or better than us? Why?
- A bit of research. Your group has been asked to produce a booklet or website of all the communication technologies that have ever been used. Here is a list of topics that might be useful.
  Morse code and telegraph, Telephone, Wireless telephones, Radio, Television, Electronic kiosks, Walkie Talkie, CB Radio, Radio hams, Speaking tubes, Remote control radios, Two-way radios, Facsimiles, Radio telescopes, Satellites, Microwave transmitters, Email, Fibre optics, Computer networks, Semaphore etc

Resources

Books:

The public library has a large selection of books on Sound and Musical Instruments in their children's section.

Websites:

http://www.firstschoolyears.com/science/sound/sound.html
Worksheets, online activities and other educational resources to support teaching and learning about sound and hearing. Contains a link to BBC Science Clips: Sound and Hearing.

http://www.howstuffworks.com/hearing.htm
Lots of information on how hearing works.

http://www.timetoteach.co.uk/Unit1FSoundandhearing.html
An online educational resource, containing worksheets, homework and resources for teachers including interactive fun for kids.

http://www.cdc.gov/niosh/mining/topics/hearingloss/hlsoundslike.htm

Loud noises can damage your hearing. This website allows you to experience moderate hearing loss.

http://www.exploratorium.edu/xref/area_index.html#sound
Photos of and information about exhibits related to sound and hearing.

http://www.crickweb.co.uk/ks1science.html
Interactives related to sound for primary aged children.

http://www.scibermonkey.org/unit.htm?un=8L
This site provides links to other sites with useful information on sound and hearing.

http://news.softpedia.com/news/10-Things-About-Hearing-Sound-and-Noise-74821.shtml
10 things about hearing sound and noise.

http://library.thinkquest.org/28170/36.html
Sound under water travels at a speed that is five times greater than in the air. One might expect that hearing under water is easier but this is not so.

http://www.kented.org.uk/ngfl/subjects/science/qca/soundandhearing.htm
Contains links to other sites with interesting information on sound.

NATIONAL LIBRARY SCHOOLS' SERVICE
For books, videos and CD ROMs:
Website: http://www.natlib.govt.nz
Telephone: 0800 171717   Fax: 0800 907000
Palmerston North
Monday - Friday 8.30am - 5.00pm
Thursday 8.30am - 6.00pm (during term)
Online request form: http://www.natlib.govt.nz/cis-online-request

BACKGROUND INFORMATION

What is sound?

Sound is a form of energy. Sounds are made when an object vibrates, or moves back and forth very quickly. The moving object makes the air around it vibrate too. These vibrations travel through the air as sound waves. When the vibrations reach our ears, we hear the sound.

You can't always see the movement of the object that is vibrating, but you can often feel the vibrations it makes.

Sound waves travel through solids, liquids and gases. Each material carries sound differently. A material that carries sound well is called a good conductor of sound.

How do humans make sound?

At the top of your windpipe, behind the Adam's apple, is the larynx, also called the voice box. Inside the larynx are folds of tissue called the vocal cords that vibrate when you speak or sing. By forcing air from our lungs past the vocal cords, we produce sound. When we speak and sing, we make constant adjustments to the tension of our vocal cords, the shape of our mouth and the speed of the expelled air. By doing this we can control the pitch, tonal quality and loudness of our voice.

The vocal cords of boys and girls are about the same length. As a girl gets older, her vocal cords stay about the same length. As a boy gets older, his vocal cords get longer and the larynx gets bigger, so his voice becomes lower.

Pitch and volume

Sounds are made when something vibrates. When it vibrates fast, we hear a high sound. When it vibrates slowly, we hear a low sound. This is called the pitch. By changing the length of the strings on a guitar, a guitar can make different notes. You shorten a string by moving your fingers along the frets. When a short string is plucked, it vibrates very fast, and we hear a high note. When a longer string is plucked it vibrates more slowly, and we hear a low note.
The size of a vibration is called amplitude. When a guitar string is plucked firmly, it makes a louder note. If the same string is plucked gently, a quiet note is made. Loudness is related to the amount of energy used to make the vibration – high amplitude, that is a loud sound, means lots of energy. Turning up the volume on a TV or CD player doesn't change the pitch, it just makes the vibrations of the speakers bigger and we hear a louder sound.

Sound waves

Sound moves from place to place, but it needs something to travel through. A rocket hurtling through space 120km above the earth where there is very little of the earth's atmosphere (i.e. mixture of gases that surround the earth) remaining would not make anywhere as near as much noise as it would on Earth.

Air is made up of tiny particles called molecules. Something that makes a noise causes the air molecules around it to vibrate. These in turn cause molecules further away to vibrate. Air molecules are squeezed together and moved apart in pulses that move away from the source of the sound.

These pulses of air movement make up what are called sound waves. Sound waves are not like water waves. In water waves, the water molecules move up and down as the waves pass through. Sound waves move by squeezing and stretching as molecules vibrate (think of a "slinky").

The speed of sound

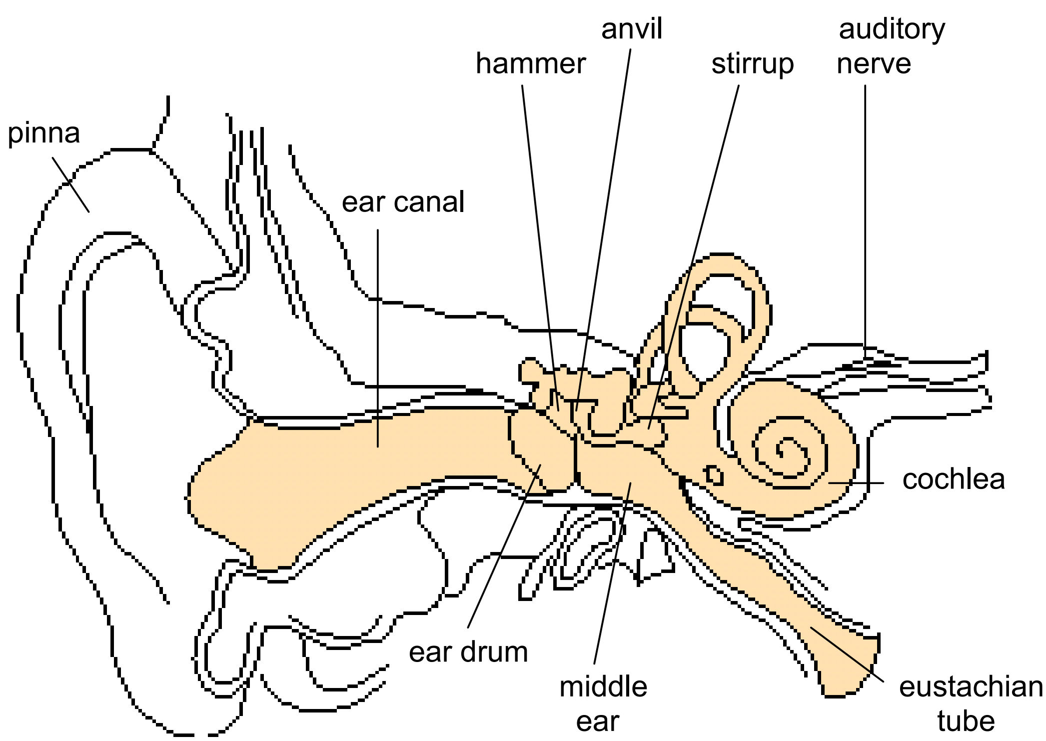
Sound travels much slower than light. Lightning and thunder come from the same event in a storm, but you see the lightning before you hear the thunder. We see light almost instantly, but the sound takes about three seconds to travel 1 kilometre. Watch for the lightning, then count the number of seconds until you hear the thunder. Divide the number of seconds by 3 to find out how far away the lightning is. For example, if the sound took 6 seconds to reach you, the storm is 2km away.

Loud sounds travel at the same speed as quiet ones. High notes travel at the same speed as low ones. However, sound does travel at different speeds at different altitudes and different temperatures.

Sound travels through solids and liquids faster than through air. This is because molecules in solids and liquids are already close together. This feature of sound is used to distinguish between different parts of the body in ultrasound.

Speed of sound through	air	340 metres per second
	water	1500 metres per second
	steel	6000 metres per second

The human ear



Hearing sounds

Hearing sound is important to us. It helps us communicate, we are entertained by sounds, sound helps us to know where we are and can warn us of danger.

The ear and how we hear

The only part of the ear that we can see is the outer ear, which acts like a funnel to collect sound. Some animals have really big ears, or special shaped ears, to help them collect sound.

The working of the inner ear is a story of vibrations. The outer ear channels sound waves to the eardrum, which is a piece of skin stretched tight like a real drum. The vibrating air causes the eardrum to vibrate. The vibrations are passed on through three tiny bones, called the hammer, anvil and stirrup because of their shapes. Bone is dense so it carries sound well, and because of their shapes, these bones amplify the sound. The vibrating bones set another "drum" on the cochlea moving. Vibrations from this move a liquid inside the spiral tube of the cochlea, which in turn moves tiny hairs inside the tube. These hairs convert the vibrations to electrical signals, which are sent to the brain by nerves. It is interesting to note that the way our brain receives sound involves travelling through gas (air), solids (eardrum and bones) and liquid (in cochlea).

Animal sounds

Many animals can make sounds that we cannot hear because they are either too high or too low. The highest note a human can hear is about 20,000 hertz (20,000 sound waves per second). A dolphin can hear up to 250,000 hertz. An elephant can make and hear sounds too low for us to hear. Some people use a dog whistle to call their animal. It is high, and we cannot hear it, but a dog can.

Some Māori Words Related to Sound

amplitude	kaha
anvil of ear	kurutangi
bull-roarer (musical instrument)	pūrerehua
cochlea of ear	koko
deaf, obstinate	taringa noa
ears	taringa
eardrum	tōrino
energy	pūngao
eustachian tube	ngōrongo
flute	kōauau
flute made from albatross bone	pōrutu
hammer of ear (mallet, ear pendant)	kuru
inner ear	taringa roto
middle ear	taringa waenga
nerve, auditory	io rongo
noise	tīoro
noise, drawn out	whakararā
noisy	hoihoi, turituri, tawetawe
noiseless	whakahū
outer ear	taringa waho
roar, heavy sound, rumble	haruru
semicircular canal	awakoko
silent	noho hū, whangū
silence	mūmū, nohopuku, whangū
sound	tangi, hau o te waiata
sound, harmonious	whakarekareka
sound waves	parangēki
speak	kōrero
Stirrup of ear	honoroto
technology	hangarau
telephone	waea kōrero, ringi, whounu, waea
television	pouaka whakaata, tīwī, terewīhana
vibration	hawahawa, ngateri, ngatari
voice	reo
voice box	pūkorokoro

What's in the exhibition?

Vibrations through the air

Sound in a vacuum?

This exhibit demonstrates the effects of atmosphere on sound. As the visitor stands on the mat the bell starts ringing. The left hand button is pushed to create a vacuum inside the dome, the sound of the bell diminishes. The right hand button is pushed to let air back into the dome, the sound of the bell increases. Can you hear a space craft explode in space? Why?

Air Canon

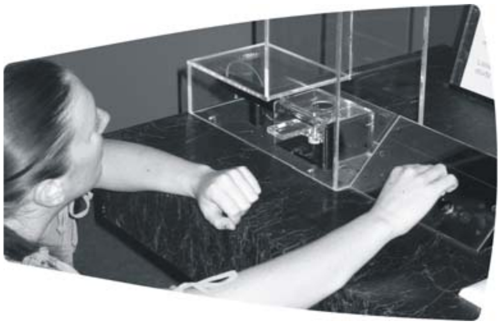
This large plastic barrel on a stand has a movable diaphragm at one end and a hole at the other. Visitors blast pulses of air at targets such as other visitors. But what has this got to do with sound?

Waves

Visitors can change the frequency of the mechanical wave driver from 0.1Hz to 5 kHz. The driver is attached to both a string for transverse wave patterns and a spring for longitudinal wave patterns. Which frequencies produce the best results in the spring and string?

Radio by Modem

Visitors rotate a mirror to bounce a laser beam from a transmitter onto a receiver. The laser beam is pulsed (or modulated) to transmit a radio sound signal. A special receiver then converts (demodulates) the light signal back into sound.



Lissajous Patterns
Visitors manipulate frequency and amplitude of vertical and horizontal laser generated wave patterns to create shapes. Can you create a perfect circle? A figure 8?

Feeling Low
'Feel' the sound coming from a speaker as vibrations move the air particles around it.

How you make and hear sound

Artificial Larynx
Experience what it is like to use an artificial larynx to communicate. Your larynx (or 'voice box') contains your vocal cords. Sometimes people have to have their larynx removed and use an artificial one instead. You may have to practise a little to make an understandable voice.

The human sound machine
This model shows a cutaway head and the label explains the process of making sound using the vocal cords.

Hear Here!

Your ears are specially designed to pick up vibrations in the air and turn them into nerve pulses that your brain understands as sounds. This large model shows the inner part of the human ear, accompanied by an explanation of the hearing process.

Hear Today, Gone Tomorrow

The delicate parts inside our ears can be damaged by too much loud noise. This exhibit simulates varying degrees of deafness.

Frustrating Phone

This is an ordinary looking phone, with a delayed feedback system. The visitor speaks into the phone and experiences confusion as their feedback loop is delayed.

Sound Target

This exhibit explores the way two ears are useful for establishing the direction a sound comes from.

<u>Making Music</u>

Harps

These three harps isolate the variables for changing the pitch of sound; length of string, thickness of string and tautness of string.

Tea Chest Bass

The classic instrument, with string, broomstick and a box to encourage the visitor to explore the relationship between pitch, string length and tension

Slap-a-phone / Bongo Pipes

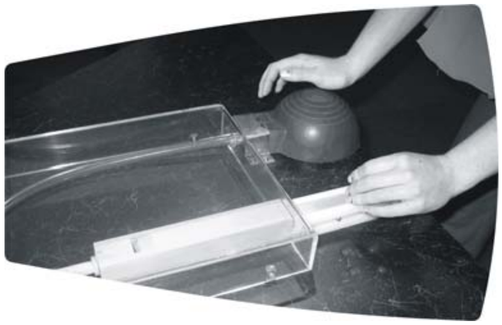
Explore the relationship between pitch and pipe length. When you hit the end of one of these changeable pipes, the column of air inside it vibrates at a certain frequency depending on the length of the pipe. You may even get a tune out of them.

Chimes

Visitors can hear the different sounds chimes make when they are different lengths. Visitors explore how the length and width of the tubes affect the pitch. How does this compare with changing notes on stringed instruments?

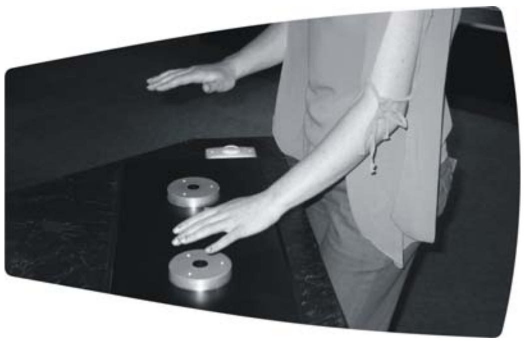
Gamelans

Striking with a hammer plays these three similar looking wooden chime boxes (gamelans). The resulting sounds are quite different. Can you figure out why?



Organ Pipe

Pump a bellows to push air through a whistle. Sliding a block, which also reveals the note being played, changes the pitch of this swanee type whistle.



Theremin

One of the first “electronic” instruments invented, the theremin is played without touching! Visitors control the volume and pitch of an electronic sound by moving their hands above two infra-red sensors. Can you make a loud high note? A soft low note?

Step on Piano

Visitors get the opportunity to **take their shoes off** and dance out a tune.

Electronic Sound

Record your voice electronically on a digital recorder. This is an example of modern technology, which has no tapes or moving parts to wear out. The microphone on top is a kind of electric ear. It turns sound waves into electrical signals that can then be recorded in a digital format.

More Exhibits

Doppler Wheel

This exhibit demonstrates the Doppler effect. This is the change in pitch of a sound as the source of the sound moves towards and away from the listener. Can you think of a real life example?

Bucket Radio

Experiment to see which is the best material and shape for turning electronic vibrations into sounds we can hear. Electronic signals cause speaker magnets to vibrate. These vibrations can only be turned into sound we can hear if there is a suitable object, which will set up vibrations in the air. Which is the best object to set up vibrations in the air? What else will work?

Frequency Multiplexing

Visitors strike a xylophone, a microphone picks up the note. The frequencies are electronically filtered and some cause different objects to respond. Can you get the object to respond without using the xylophone?

Projections

These projections throughout the exhibition are equivalent to a spectrum analyser and will respond to sound (noise).