PART 3

Part 3: How is sound transmitted?

Activity 3.1	Bang, bang!
Activity 3.2	Speed of sound
Activity 3.3	Seeing with sound
Activity 3.4	Hearing
Activity 3.5	Music to my ears

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Activity 3.1 Bang, bang!

Activity type

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Making sounds

What to use:

Each PAIR will require:

- ruler
- elastic band
- eraser
- tuning fork
- rubber bung
- beaker of water.

What to do:

Step 1
Place the ruler on the edge of the bench so no more than 4 cm touches the bench.

Step 2
Twang the free end of the ruler. Record your observations in your ***Notebook*** as you gradually move more of the ruler in contact with the bench.

Step 3
Make a model guitar with a ruler, elastic band and eraser. What happens as you move the eraser's position? Record your observations.

Step 4
Secure the rubber bung on the end of the tuning fork. Strike the tines of the fork against the sole of your shoe and record your observations as you raise the fork towards your ear.

Step 5
Hold the beaker of water next to your ear and have your partner place the vibrating tuning fork's bung in the water (do not submerge it). Record your observations.

Discussion:

1. Compare a vibrating ruler with 4 cm in contact with the bench and a ruler that has 6 cm in contact with the bench.
2. How could you improve the model guitar?
3. Was there a difference in the sound of a vibrating tuning fork held in a rubber bung and a vibrating tuning fork held in a rubber bung that is partly immersed in a beaker of water?

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Where is the sound?

What to use:

Each STUDENT will require:

- one disposable ear plug.

What to do:

Step 1
Sit still. Close your eyes. Listen carefully.

Step 2
One person in the class moves very quietly to a new position and makes a soft sound.

Step 3
All students point to where the sound came from.

Step 4
Students now insert their ear plugs and repeat the experiment.

Discussion:

- Why are our ears on the sides of our heads?

Click here to find out more about sound and how it travels.

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Activity 3.2 Speed of sound

How fast does sound travel in air?

What to use:

Each GROUP will require:

- metre ruler
- data logger with leads
- ultrasound sensors.

What to do:

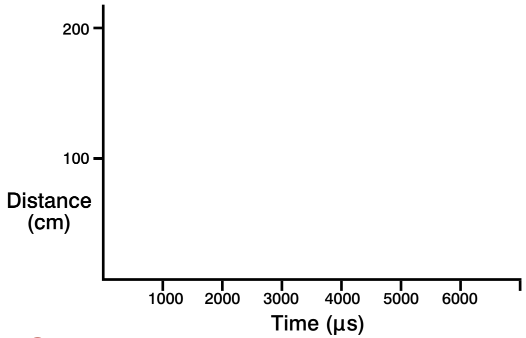
Step 1
Measure a distance of 20 cm from the wall to the sensor.

Step 2
Connect the ultrasound sensor to the data logger. From the menu select "meter", then "time".

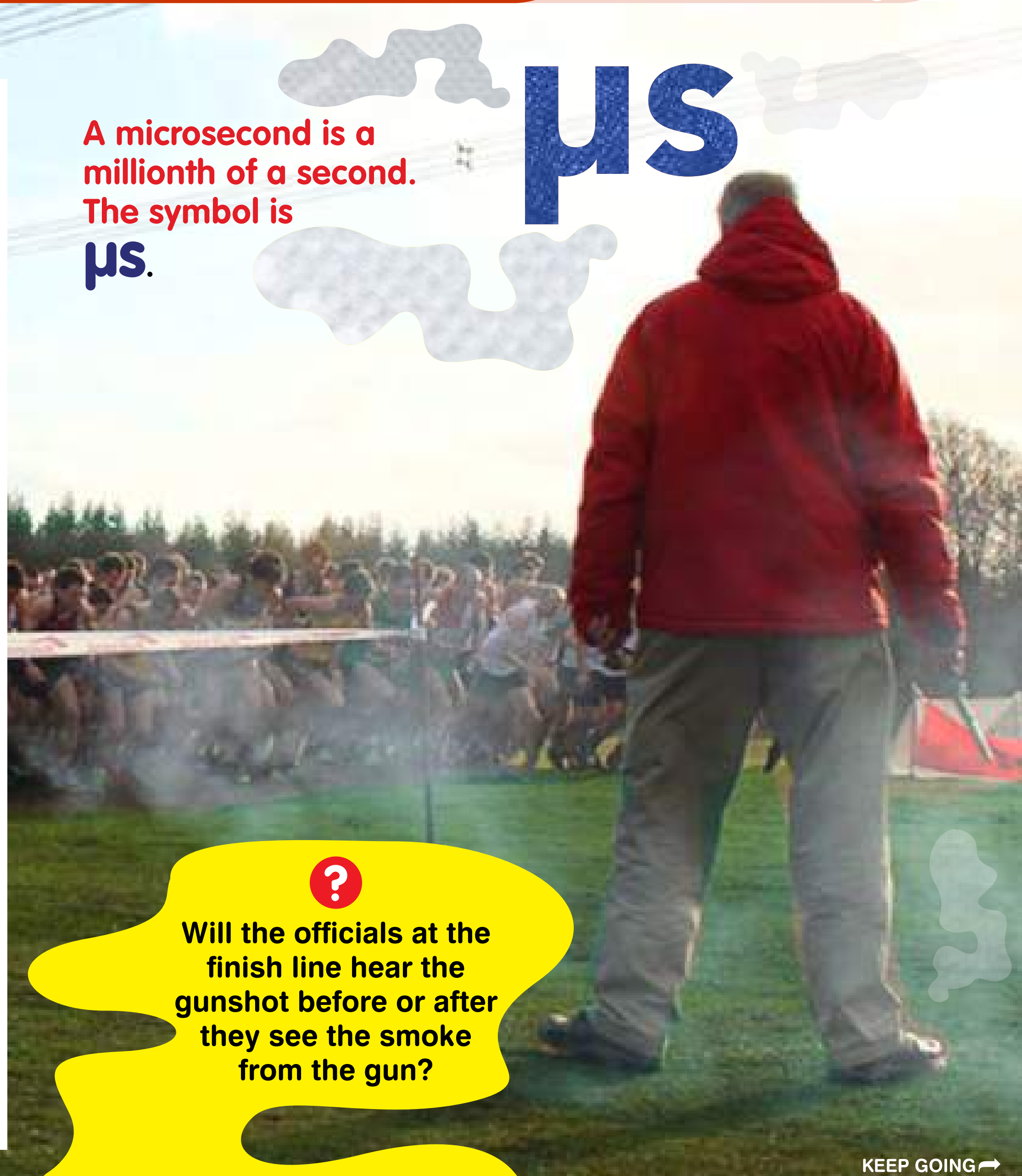
Step 3
The sensor will immediately begin recording the time it takes, in units of microseconds, for the sound to travel from the sensor to the wall and back again. Record this data in an appropriate table.

Step 4
Repeat Steps 1 and 3 for measurements of 40 cm, 60 cm, 80 cm and 100 cm.

Step 5
Plot a graph, with time taken on the x-axis and distance travelled on the y-axis. Remember that the distance the sound travelled is double the measured distance.



Step 5
Determine the slope of your graph.
In this case:-
slope = rise/run = distance/time = speed
Work out the speed of sound in air in cm/μs.
Challenge – Can you convert your speed of sound to m/s?



A microsecond is a millionth of a second. The symbol is μs.

μs

Will the officials at the finish line hear the gunshot before or after they see the smoke from the gun?

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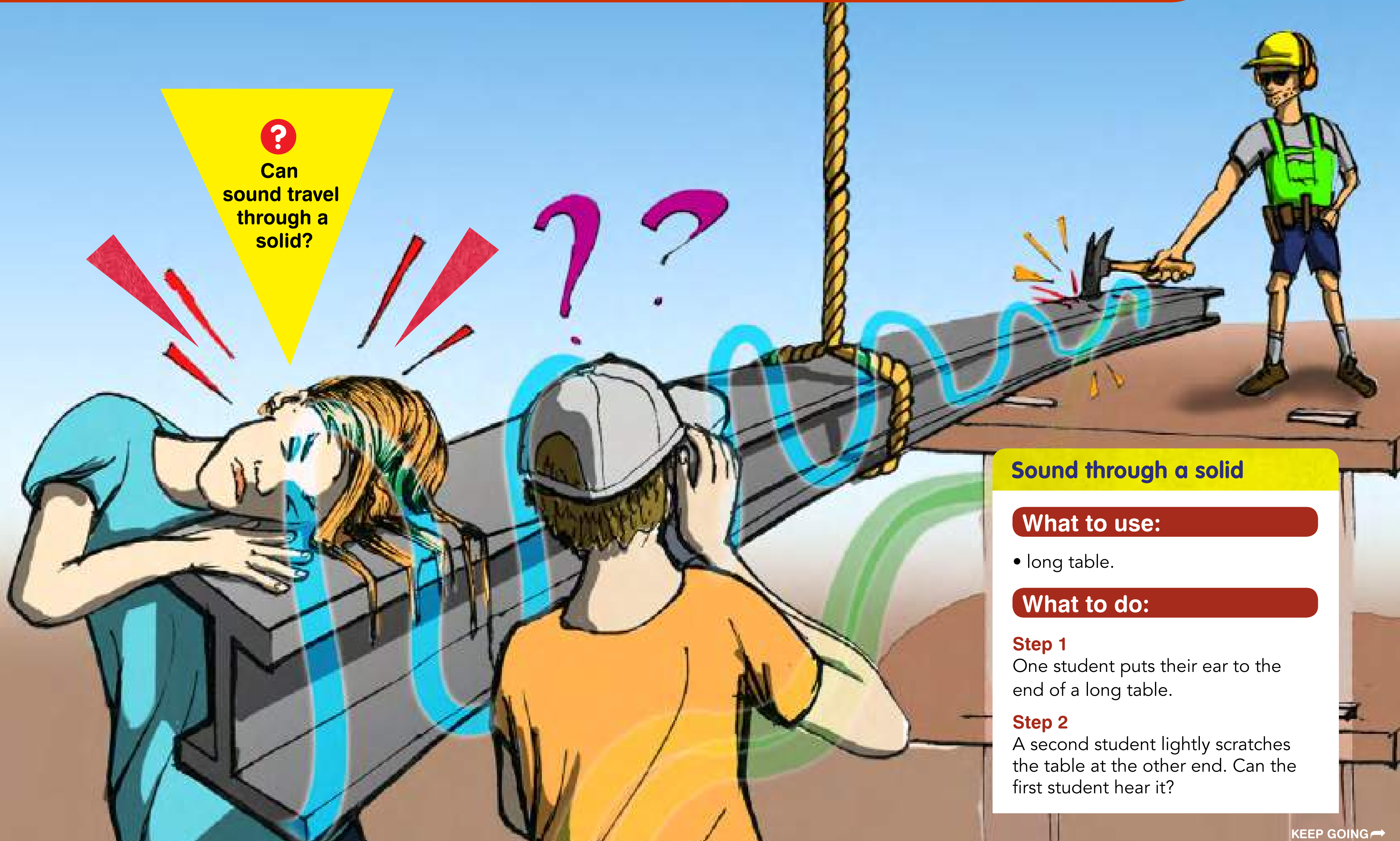

Sound through a solid

What to use:

- long table.

What to do:

Step 1
One student puts their ear to the end of a long table.

Step 2
A second student lightly scratches the table at the other end. Can the first student hear it?

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Sound through a liquid

What to use:

- bucket of water
- large screw top jar with lid
- kitchen timer or mobile phone.

What to do:

Step 1
Make the kitchen timer ring or the mobile phone play music before putting it into the jar and sealing it well with the screw top lid. Can you still hear it?

Step 2
Hold the jar under water in the bucket. Can you hear any noise?

Step 3
Put your ear onto the water and listen. Can you hear any noise?

Does sound always travel at the same speed? Click here to find out.

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Activity 3.3 Seeing with sound

Activity type

How do vets see inside your pet?

How do dolphins find their prey?

Click here to find out more about seeing with sound.

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Activity 3.4 Hearing

Activity type

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Several factors can affect hearing:
- **age**
- **an exposure to loud noises**
- **the frequency of exposures to loud noises**
- **disease.**

Hearing different frequencies

What to use:

The CLASS will require:
- signal generator
- loudspeaker.

Step 1
Connect a signal generator to a loudspeaker.

Step 2
Begin with a low frequency. Everyone who can hear the sound raises their hand.

Step 3
Slowly increase the frequency of the sound. When anyone can no longer hear the note they drop their hand. Continue increasing the tone until the whole class has dropped their hands.

Discussion:

1. How many people were tested?
2. How many people could hear 12 kHz?
3. How many people could hear 18 kHz?

Are all ears the same?

Can you hear quieter noises than your partner?

Background noise

What to use:

Each GROUP will require:
- variety of noise-making devices, such as rulers, shakers, pens, iPods etc
- two pieces of card per group
- decibel meter.

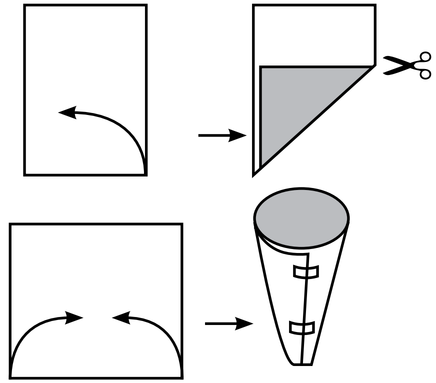
Step 1
Form groups of six. Each group will have:
- distractors - four people who will make sounds.
- conversationalists - two people who will try to hold an intelligent conversation, despite the noise.

Step 2
The distractors decide how to make noise of at least three different levels.

Step 3
Each groups' conversationalists sit opposite each other, about a metre apart.

Step 4
Begin the activity.

Step 5
Repeat the exercise, but give one conversationalist in each pair a hearing cone (made from the card) for each ear.



Step 6
Swap roles and repeat.

Discussion:

1. Did the cone help?
2. Was there a volume at which it became impossible to concentrate?

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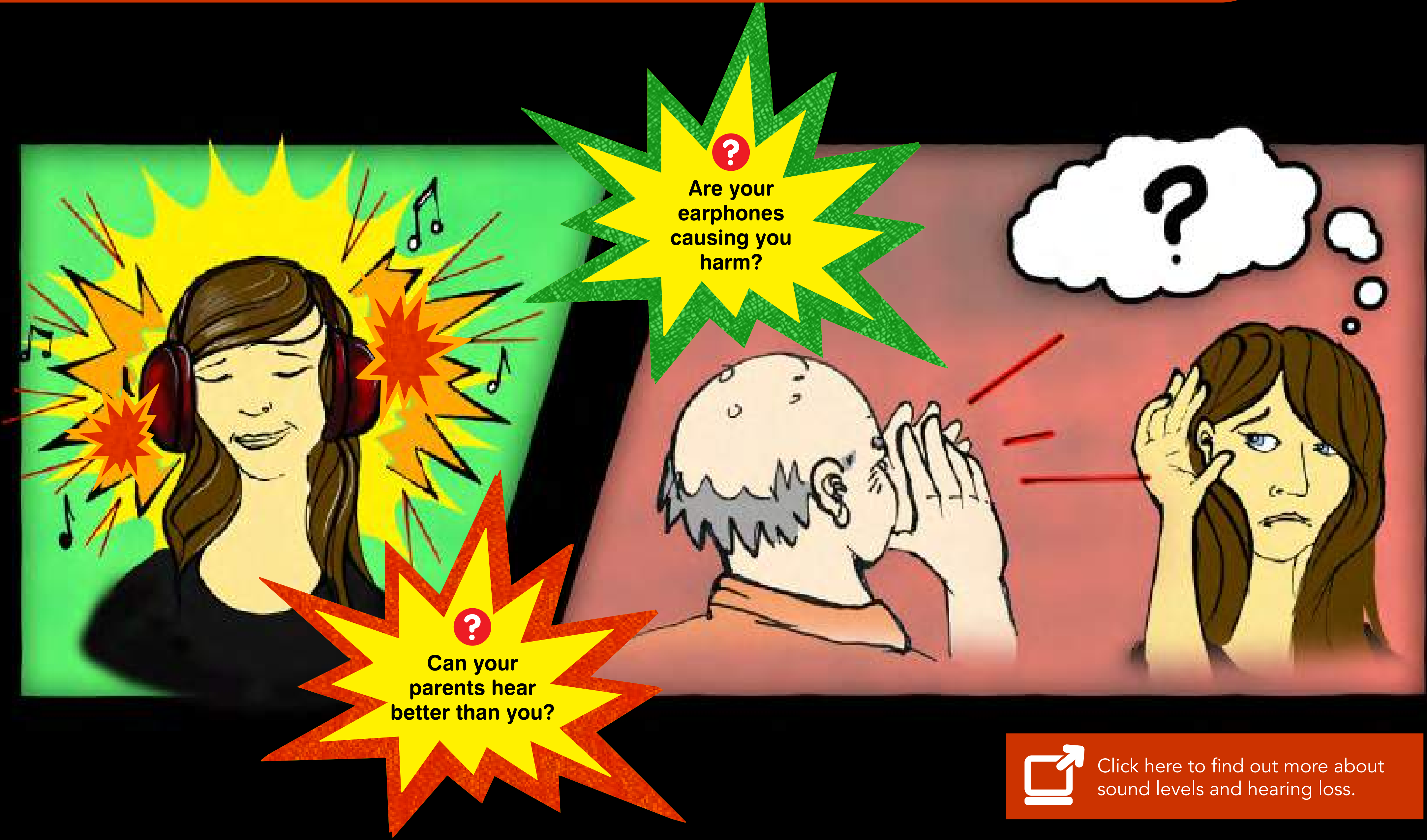

Click here to find out more about sound levels and hearing loss.

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Activity 3.5 Music to my ears

Activity type

How much do you understand about sound?

What to do:

Step 1
Think back to **Activity 3.1 Bang, Bang!** and how sound was created. Choose a musical instrument you like (it does not have to be one shown here).

Step 2
Think about how the instrument produces different notes and how the amplitude is altered.

Step 3
Choose a method of presenting your ideas from the guitar on the right.

Step 4
In your presentation, use as many scientific terms as you can from the box top right.

How do musical instruments work?

SCIENTIFIC TERMS

AMPLITUDE
FREQUENCY
PRESSURE
VIBRATION
WAVELENGTH

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Summary

PART 3

A sound wave is a **longitudinal wave**. The particles move forwards and backwards in the direction of the wave. This is different to water waves which are **transverse waves**. In water waves the water particles move up and down at right angles to the direction of the wave.

The pitch of a sound is determined by the **frequency** of the vibration. The higher the pitch, the greater the frequency. The volume or loudness of a sound depends on the **amplitude** of a vibration.

Sound cannot travel through a vacuum because there are no particles in a vacuum to transmit the sound vibrations.

Sound travels at different speeds in different media. In air it travels at 340 m/s. Sound travels faster through water, and faster still through iron or glass.

Jet planes travelling at the speed of sound **(Mach 1)** produce a **sonic boom**. This is a shock wave that moves at the speed of sound outwards and rearwards in all directions. A stock whip also make a sonic boom (whip crack) when it exceeds the speed of sound.

Sound waves can be reflected from objects. If you shout ‘hello’ in a canyon, you hear an **echo**. The time it takes for the echo to be heard indicates how far away the canyon walls are. A bat emits a very high frequency sound (outside human hearing range) and the various reflections, or echoes, it receives back allow the bat to construct an image of its surroundings. This is called **echolocation**. A blind person can use the same echolocation technique to engage with the world around them. Ships use a device called **sonar** to 'see' their surroundings. The ship emits a sound into the water and listens to its echoes to determine depth or the presence of other vessels. Toothed whales use ultrasound to communicate with each other and find fish prey.

The **ultrasound scan** uses very high frequency sound waves (ultrasound) to see an unborn child in the uterus. A trained professional, called a **sonographer**, moves a plastic **transducer** over the mother’s belly. The transducer emits high frequency sound waves into the body. The sound waves hit tissues, echo back to the transducer and are interpreted by a computer to form images on a screen.

The **Doppler effect** occurs when a sound source (or light source) is moving. The movement causes a change in frequency. When a train sounding an air horn approaches, you hear an increase in pitch. As the train passes and travels away there is a decrease in pitch.

We have two ears to help us determine where a sound is coming from. The purpose of the ears is to focus, amplify and interpret sound waves, as well as help our sense of balance. The ear has three parts – outer (**pinna, ear canal, eardrum**), middle (**ossicles**) and inner (**cochlea** and **auditory nerve**).

The full hearing range of young humans is 20 – 20,000 Hz. This is limited compared to other animals.

Sound levels are recorded on a logarithmic scale of **decibels** (dB). A ten-fold increase in sound intensity is equivalent to an increase of 10 dB. A 100-fold increase in sound intensity is equivalent to an increase of 20 dB.

Current research indicates using earphones could be causing hearing loss. Earphones can produce a maximum of 100 dB, equivalent to attending a rock concert. Our hearing range changes with age, but is also affected by damage from disease or over-exposure to loud noises. Hearing loss cannot be reversed, however Australia’s **Professor Graham Clark** has been at the forefront of the technology of **cochlear implants** that can restore hearing to deaf people. There are a number of strategies for making listening safe: e.g. earplugs, noise-cancelling earphones, safe listening levels, limiting time exposures.

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