3.1 Bang, bang!

Lesson outcomes

At the end of this activity students will be able to:

- define frequency, amplitude and pressure
- explain how sound is made
- explain why sound doesn't travel through a vacuum.

What ideas might your students already have?

Students may have the misconception that sound can travel through a vacuum or that air isn't a substance that could interfere with its progress.

Key vocabulary:

Longitudinal wave, compression, rarefaction, amplitude, frequency, pressure, vacuum, vibration, wavelength.

Equipment list:

Each GROUP will require:

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

Each STUDENT will require:

- disposable ear plug
- ***Notebook.***

Things to consider:

You may wish to run this as a circus of activities, depending on the number of tuning forks you have available. This would mean having stations for each activity set up around the classroom so students cycle through the tasks.

You may wish to use a slinky to demonstrate the pulse and wave differences.

Teacher content information:

Essentially there are five parts to the activity – twanging rulers, making a guitar ruler, listening to a tuning fork, finding the direction of source of sound and the bell in a vacuum video. You may wish to expand the range to include making a model drum or have students bring instruments to play.

The main aim is to engage students with the topic of sound and introduce the terms frequency and amplitude in place of the real world equivalents of pitch and volume.

When the students use the bung and water to transmit sound, they should find the sound appears louder due to the fork causing additional vibrations. The sound produced by the tuning fork is barely audible to students. However, if the tuning fork is set upon the bung (or in water), the bung begins vibrating at the same natural frequency of the tuning fork. The tuning fork forces surrounding rubber particles to vibrate. The vibrating bung in turn forces surrounding air particles to vibrate and the result is an increase in the amplitude and thus loudness of the sound.

Lesson plan

Step 1: Introduce the activity by asking the students whether they play a musical instrument. Explain today's activity will involve making a model guitar. What do they think will be needed and why?

Step 2: During the activities encourage the students to **Notebook** their observations.

Step 3: Conclude with a quick discussion of whether they noticed a difference with the beaker of water? Was it louder/quieter? What was happening?

Step 4: Direct students to the student digital and the concept of longitudinal waves. After completing the digital activities encourage students to share their understanding of sound – watch for misconceptions.

Suggested question/s:

- How do we make louder sounds?
- How do we make deeper sounds?
- How could we improve the model guitar?
- Why do you think …?
- Why do most animals have two ears?

3.2 Speed of sound

Lesson outcomes

At the end of this activity students will be able to:

- describe a method for determining the speed of sound
- calculate the speed of sound
- explain the reason sound travels at different speeds.

What ideas might your students already have?

Students should already know that speed is measured in metres per second. Students may have the misconception that the speed of sound is constant or that it travels slower in solids because there is stuff in the way.

Key vocabulary:

Data logger, distance, medium, microsecond, slope, speed, time, ultrasound.

Equipment list:

The CLASS will require:

- starter pistol and caps.

Each GROUP will require:

- stopwatch
- ultrasound sensors
- metre ruler
- data logger.

Each STUDENT will require:

- ***Notebook.***

Things to consider:

- Depending on your number of sensors, you may wish to rotate students through the data collection phase in groups of four, while others begin the *Science by Doing* **Student Digital** activity.
- The instructions for the data logger in the *Science by Doing* **Student Guide** are for a Data Harvest data-logging system – you may need to alter these for a different system.
- If doing the starter pistol activity (see below) you will need to consider whether additional staff are required and whether you are comfortable firing the gun.
- The plotting of the line graphs in both activities allow students to calculate the slope of the lines. The slope of the line is speed (speed = distance/time).
- You may wish the students to use graphic calculators or Excel for the graph plotting.
- You may wish to have students explore why the medium affects the speed of sound in more detail than the separation of particles. You could use a model of a toy train with trucks connected by springs to represent the particles and the springs to show the bonds (intermolecular/hydrogen/polar) between them, but this would be an extension activity only.

Teacher content information:

Measuring speed of sound with a starter pistol on the school oval.

You may wish to have students measure the speed of sound manually using a starter pistol and caps. Have students record the time it takes from them seeing the smoke to hearing the sound. This will only work if you can position the students at least 200 m from you in clear line of sight. Students can use the stopwatches on their mobile phones. You may need an additional member of staff to be with the students 200 m away from you. Wear ear muffs and place a cap in the gun. Use a signal to ensure students are watching and have set their timers. Hold the gun above your head, preferably against a clear dark background. Students start timing when they see the smoke from the gun. Repeat several times and then share all data from the students on return. This is a rich activity for discussing reliability. You may also wish students to calculate the speed directly from each measurement, rather than plot a graph. This activity is not included in the Student Guide but there is an image of a starter pistol and sprinting race for class discussion.

A longer version of the video on the sound barrier in the **Find out more** activity can be found at http://www.youtube.com/watch?v=rMc9t8U-oC0. The short video mentions the speed of sound as 330ms-1 and you could use this to introduce the idea of speed being air-temperature dependent.

Traffic light activity

Ask students to hold up a red, yellow or green card, depending on whether they don't know, are unsure or confidently know the outcome. You may allow students to keep the cards in their pencil cases for future use.

Lesson plan

Step 1: Introduce the activity by asking students what they know about the speeds of sound and light. Explain they will be investigating the speed of sound (in two ways if using the starter pistol).

Step 2: Demonstrate how to operate the data logger (and any modifications you need to make to the method in the guide).

Step 3: During the activity, encourage students to record their observations, compare with others and check they are coping with the mathematical skills required.

Step 4: Conclude the activity with a class discussion on what the speed of sound is and what surprised them. A traffic light activity would be a useful indication of learning.

Suggested question/s:

- Do sound and light travel at the same speed?
- Does sound travel at only one speed?
- Will the officials at the finish line hear the gunshot before or after they see the smoke from the gun?
- Why do you think …?
- Does it take longer for sound to travel through steel than air?

Follow up:

The **Student Digital** component could be set as a homework exercise.

3.3 Seeing with sound

Lesson outcomes

At the end of this activity students will be able to:

- explain the production of echoes
- explain the Doppler effect with regard to sound
- describe a use for ultrasound.

What ideas might your students already have?

Some students may know that bats use echolocation and that dolphins/whales communicate at high-frequency.

Key vocabulary:

Echo, echolocation, reflection, sonar, ultrasound, Doppler effect.

Equipment list:

Each STUDENT will require:

- internet access
- access to a computer with Flash Player
- ***Notebook***

Teacher content information:

There is the opportunity to invite a visually impaired member of the community in for this lesson, so students can find out how they interpret the sounds around them as images. This is a key chance to highlight community awareness and understanding science as a human endeavour.

Lesson plan:

Step 1: Introduce the activity by asking students how blind people navigate around a room. Has anyone had an ultrasound scan? How do they work? Collect their ideas on the board for later discussion.

Step 2: Invite the students to explore the digital activities.

Step 3: Conclude with a class discussion. Encourage students to share stories they relate to the content.

Suggested question/s:

- How do dolphins find their prey?
- How do vets see inside your pet?
- How do boats determine depth?
- How do police clock the speed of moving cars?

3.4 Hearing

Lesson outcomes

At the end of this activity students will be able to:

- describe how sound is heard
- explain the decibel sound level system
- construct a scientific investigation of the effects of earphones on hearing.

What ideas might your students already have?

Some students will be aware that hearing is affected by age, but will be less aware of the dangers of prolonged exposure to loud noises; merely thinking it is uncomfortable.

Key vocabulary:

Cochlear, decibel, ear, frequency, hearing, volume.

Equipment list:

The CLASS will require:

- loud speaker
- signal generator
- decibel meter.

Each GROUP will require:

- 2 pieces of A4 card
- variety of sound-making devices, such as pens, rulers, drums, shakers, earphones and phone.

Each STUDENT will require:

- ***Notebook***

Things to consider

- You may wish to use an oscilloscope to show the signal visually, as well as the audio tone.
- Students with hearing aids will need to adjust them for the high frequencies.
- For the group activity you may have limited noise-making devices and therefore might want to change the group sizes accordingly.
- You may wish to use the Scootle resource Body parts: hearing (L721) (http://www.scootle.edu.au/ec/viewing/L721/index.html) to recap how sound travels through a human ear.

Teacher content information:

There are a number of strategies for making listening safe; e.g. earplugs, noise-cancelling earphones, safe listening levels, limiting time exposures. Look in this **World Health Organisation publication**.

Lesson plan:

Step 1: Introduce the activity by asking if everyone in the room has the same hearing ability. Discuss the variables they put forward – e.g. age, music ability, attending concerts, distance from source. Inform the class that this activity will reveal different hearing ranges amongst students.

Step 2: Operate the signal generator at the lowest frequency and begin raising the frequency. Ask students to raise a hand when they can hear the sound and drop their hand when they can no longer hear the sound.

Step 3: Begin a class discussion about the reasons for any differences found.

Step 4: Form groups of six. Have two students talking to each other and four students as audio distracters. Ensure the students conduct themselves respectfully during this investigation and record their observations. Each group briefly reports back.

Step 5: Invite students to begin the digital activities. You might like to project the videos onto a screen for class viewing.

Step 6: Ask students to work in pairs to tabulate all the sound level activities they experienced yesterday. Assist students in interpreting the information displayed in the two graphics. Compare student answers to the discussion questions.

Step 7: Invite student pairs to begin the ***Notebook*** activity: - Can you use either of these tests to devise an investigation into how using earphones affects your hearing?

Step 8: Allow student pairs to describe to the class their suggested investigations.

Suggested question/s:

- Are all ears the same?
- Can you hear anything I can't?
- What causes damage?
- Are your earphones/headphones causing you harm?
- Can your parents hear better than you?

Follow-up:

Ask students to explore the **Find out more** section for homework. It describes the incredible work Professor Graham Clark has done in helping deaf people to hear.

3.5 Music to my ears

Lesson outcomes

At the end of this activity students will be able to:

- share what they have learned so far about sound
- apply their understanding of sound to a musical instrument.

Equipment list:

Each STUDENT will require:

- ***Notebook***
- computer access or paper.

Things to consider

- Guidelines for **Concept Maps** can be found on page 9 of the *Science by Doing* Professional Learning Module **Inquiry-based Teaching**.
- How much experience do your students have in constructing **Concept Maps**?
- Do your students know their preferred method of summarising and, if so, should they challenge themselves to use an alternative technique?
- What will be the most effective way to give feedback?
- How will you build on these understandings in future lessons?
- Refer to the *Science by Doing* Professional Learning Module **Assessment** for further information on the role of **formative assessment**.

Lesson plan:

Step 1: Briefly discuss the sound section with the students. Explain they will create a **Concept Map**/demonstration/oral/cartoon series/story to show what they have learned so far about sound and apply it to a musical instrument of their choice.

Step 2: Allow students time to plan and construct their presentation.

Step 3: Encourage students to add any further terms and linking words to their presentations.

Step 4: Collect and read students' presentations. Provide feedback regarding their progress, strengths and weaknesses in their understanding of concepts.