Science Stage 5 Physical world

## Sound waves

Students are guided in completing a short investigation and submitting a brief report and reflection.

Stage 5, PW1 Energy transfer through different mediums can be explained using wave and particle models.

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| Guiding question: | How does the wave model describe the structure of sounds? |
| What are your students going to learn? (Objectives) | PW1c - describe using the wave model, the features of waves including wavelength, frequency and speed.  WS6 Students conduct investigations by:   1. safely constructing, assembling and manipulating identified equipment   WS9 Students communicate by:   1. using appropriate units for physical quantities and symbols to express relationships, including mathematical ones |
| How are they going to learn it? (Resources and Strategies) | Students will use a [virtual oscilloscope](https://academo.org/demos/virtual-oscilloscope/) to observe the wave created by specific sounds. Students can submit an experimental report that documents their activity and the results obtained. |
| Target date for completion | 2 lessons. |
| How are you going to know that they learned it? (Success criteria) | In the submitted experimental report students can:   * Clearly articulate their investigation * Perform appropriate calculations of the results |
| Collecting evidence of student learning (Verification) | Students will produce a concise experimental report outlining the process undertaken and the results obtained. This report could be submitted via e-mail, Google Classroom or Microsoft Teams to the teacher for feedback. |
| Differentiation including HPGE | Adapting process – students can perform this activity extending through the use of the [wave interference and beats](https://academo.org/demos/wave-interference-beat-frequency/) and/or [spectrum analyser](https://academo.org/demos/spectrum-analyzer/) for more complex sound patterns for their report. |
| Feedback (Evaluation) | Teachers can provide feedback via the submission pathway (e-mail, Google Classroom or Microsoft Team) to students on their progression towards the learning outcomes. An example [rubric for the Working Scientifically Skills](https://schoolsequella.det.nsw.edu.au/file/bebc596d-7e55-4bf2-83dc-be16daabe9fd/1/science-s45-rubricskills.docx) can be found on the Science Curriculum Support website. |
| Communication | Students and teachers can interact either synchronously (Google Hangouts, Microsoft Teams) or asynchronously (email) to provide ongoing feedback and support to students for their learning. |

### Resources:

* [Virtual oscilloscope](https://academo.org/demos/virtual-oscilloscope/) is an online oscilloscope that can use the microphone on laptops or mobile devices to produce the simulated oscilloscope trace.
* [Wave interference and beats](https://academo.org/demos/wave-interference-beat-frequency/) is a tool to analyse the interaction of different waves to produce beats from the constructive and destructive interference patterns.
* [Spectrum analyser](https://academo.org/demos/spectrum-analyzer/) is a tool to analyse the sound amplitudes and frequencies in more complex sound patterns in example files or uploaded audio files.
* [Safety procedures and equipment](https://education.nsw.gov.au/asset-management/chemicals/section-3-curriculum-support-documents/3-2-science/3-2-2-safety-procedures-and-equipment) on CSIS contains information required to ensure students are able to safely undertake this activity3
* [Investigative science](https://education.nsw.gov.au/asset-management/chemicals/section-3-curriculum-support-documents/3-2-science/3-2-3-good-practices-in-chemical-safety-in-science/3-2-3-6-investigative-science) on CSIS contains information required for students undertaking experimental activities away from the classroom environment

### Lesson sequence

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| Session | Learning Sequence | Evidence of learning |
| One | Students can explore the [virtual oscilloscope](https://academo.org/demos/virtual-oscilloscope/) adjusting the settings for frequency, scale (seconds/div, volts/div) and describe their impact on the oscilloscope trace. By adjusting the input students can explore different types of waves including the use of their own microphone (using the freeze input selection to see a snapshot of the wave they are producing).  Students can make measurements of the frequency and amplitudes of the waves they are producing through different actions. Sounds can be compared in terms of their frequency and amplitude based on their original sources. Students could explore:   * How high/low of a frequency can my voice produce? * How does distance to the microphone impact amplitude? * What sounds do common household objects make? * Can I make a drum set out of pots and pans?   For HPGE students this activity can be extended to look at the combination of sound waves to produce more complex sounds. [Wave interference and beats](https://academo.org/demos/wave-interference-beat-frequency/) allows students to combine different frequency waves and observe the resultant wave, using the sound on/off button to make the result audible. Students can explore the combination of various waves to demonstrate the development of complex sound patterns. This can then be further investigated using the [spectrum analyser](https://academo.org/demos/spectrum-analyzer/) to visually display the example sounds or upload a recording of their own. By examining a range of complex sounds (for example different [bird calls](https://www.xeno-canto.org/)) students can describe the mixtures of frequencies and amplitudes which difference sources have in common and those which are more unique. | Screenshots and documentation of the activity undertaken included in the experimental report. |

### Student handout

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| Steps to follow |
| The common sine wave structure looks like the following diagram. The crest is the uppermost extent of the wave and the trough is the lowermost extent of the wave. The wavelength is the distance between two adjacent crests or troughs. The frequency of a wave is the number of wavelengths which arrive (or pass) per second:    Open the [virtual oscilloscope](https://academo.org/demos/virtual-oscilloscope/) and explore the settings offered in the app. Take some time to make sure you are familiar with the operation of the controls:   1. Adjust the “input wave frequency” slider to the left and right. Take a screenshot of each wave produced and describe the differences in the oscilloscope trace. 2. Adjust the “oscilloscope gain” slider to the left and right. Take a screenshot of each wave produced and describe the differences in the oscilloscope trace.   The scale of the black lines on the screen can be manipulated by the “seconds/div” and “volts/div” selections. Each line is a division (or div) so the value in these drop-down boxes is how many seconds in time, and volts in amplitude, this sound wave represents (when the sound wave was converted to an electrical signal by the microphone). |
| At the top of the controls is the “input” selector. This can be changed to “Live Input” and the oscilloscope will use your microphone to provide the sound to the oscilloscope app. The “freeze live input” can be used to pause the oscilloscope trace so you can take a screenshot and take measurements of the waves you are producing with the microphone:   1. Create a series of high pitch and low pitch sounds using your voice, objects in your home or music played through the speakers in your computer. This will create several different waves on the oscilloscope trace. Take a screenshot of each of these. 2. Describe the difference between these sound waves in terms of:    1. Amplitude    2. Frequency    3. Shape   Explore features of the sounds you are producing, take a selection of screenshots to show the sound waves you are producing on the oscilloscope trace:   1. What is the highest and lowest frequency your voice can produce? 2. How does the distance from sound producing object to the microphone change the amplitude? 3. How do the waves produced by common household objects compare to those made by your voice? 4. Make a drum set out of pots and pans. How do these waves compare?   Present your screen shots, explanations and comparisons as an experimental report. |
| Extension activity  Different frequency and amplitude sound waves can combine to form complex sounds such as those found in bird calls.   1. Open the [wave interference and beats](https://academo.org/demos/wave-interference-beat-frequency/) app to observe the complex waves produced when waves of varying frequencies are combined. The resulting waves have a repeating structure we call ‘beats’, you can listen to this wave as sound by ticking the select box “sound on/off” at the bottom of the app control panel. While the sound is on adjust the sliders for the frequency of the two input waves to observe the impact of your changes. Take screenshots and describe each wave in terms of:    1. Frequency variation    2. Amplitude variation 2. Explore more complex sounds further using the [spectrum analyser](https://academo.org/demos/spectrum-analyzer/) app to visually display a spectrogram of all the frequencies that are present in a sound recording at a given time. The vertical scale represents the frequency of each sound present with the horizontal scale being time. The darker areas are those where the frequencies have very low intensities, and the orange and yellow areas represent frequencies that have high intensities in the sound. Explore the ‘sound samples’ provided in the app before uploading your own recordings to observe how the spectrogram represents the sounds. 3. Upload recordings of your own voice to the spectrum analyser app and compare the spectrogram of your voice to those of your peers (share your recording files with each other online) and siblings or parents. How do your voices compare in terms of the distribution of frequencies and amplitudes produced? Take screenshots of the spectrogram for each to support your conclusions. 4. Search for different [bird calls](https://www.xeno-canto.org/) online to download calls for bird species in your local area and examine the spectrogram of their sounds. How do the bird calls compare in terms of the distribution of frequencies and amplitudes produced? Take screenshots of the spectrogram for each to support your conclusions. 5. Describe the mixtures of frequencies and amplitudes which difference sources have in common and those which are more unique. This could be between humans and birds or different environmental sounds from objects in and around your home. |