Exhibit message

The average hearing range of humans is between 20 Hz and 20 000 Hz. Some non-human animals can hear above or below this range.

NB: If visitors suspect that they have a hearing problem, they should contact a hearing professional such as *Australian Hearing*.

Quick Fact

Most people can tell whether a tone is higher or lower than another. People with musical training can usually recognise the difference between notes or can sing them if given a reference tone.

Perfect (absolute) pitch is the extraordinary ability to recognize or sing a given note without referring to any other tone. Only 1 in 10 000 people have perfect pitch. It is unclear whether this ability is a learned or inherited characteristic. Some studies have shown that many babies are born with perfect pitch, but later lose the ability.

Graphic panel text

Hearing ranges are measured by:

- **Pitch** or frequency in **hertz (Hz)**. This tells us the highest and lowest tones we are able to hear.
- **Loudness** or intensity in **decibels (dB)**. This tells us how loud those tones need to be for us to hear them.

All of the tones you are hearing are the same volume, but some may sound louder and clearer than others. That is because our ears are most sensitive to frequencies which correspond to elements of human speech (1000–4000 Hz). People cannot hear frequencies that are below 20 Hz or above 20 000 Hz, no matter how loud they are.

What was that?

When hearing loss occurs with **age**, the higher frequencies are lost first. This makes it particularly difficult to hear speech. Age-related hearing loss (called ‘presbycusis’) can occur from 35 years onwards, and tends to affect men more than women. This exhibit does not represent a hearing test.

Pure tone

Single-frequency, pure tones sound strange because we are used to hearing sounds made up of more than one frequency.

Hearing ranges

Atlantic bottlenose dolphin
(*Tursiops truncatus*)
75–150 000 Hz

Humpback whale (*Megaptera novaeangliae*)
30–28 000 Hz

Human (*Homo sapiens*)
20–20 000 Hz

Domestic cat (*Felis catus*)
45–64 000 Hz

Eastern grey kangaroo (*Macropus giganteus*)
2500–30 000 Hz

Pigeon (*Columba livia*)
0.05–10 000 Hz

Goldfish (*Carassius auratus*)
30–8000 Hz

Greater horseshoe bat
(*Rhinolophus ferrumequinum*)
2000–110 000 Hz

Asian elephant (*Elephas maximus*)
16–1000 Hz

Domestic dog (*Canis familiaris*)
40–40 000 Hz

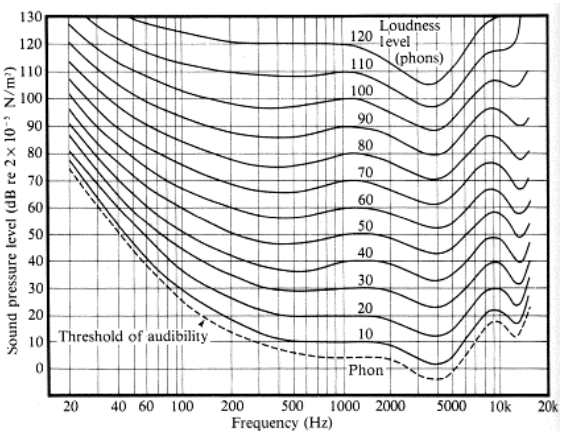
Middle C
261 Hz

Want to know more about human hearing ranges?

On average, humans can hear tones between 20 Hz (very low tone) and 20 000 Hz (very high tone). Tones below 20 Hz are classified as **infrasound** and those above 20 000 Hz as **ultrasound**.

In reality the boundaries are not clear and sharp, and it is rare for a person to hear as high as 20 000 Hz. For a young, healthy person, 17 000–18 000 Hz is considered a good upper limit. Sounds below 30 Hz are difficult to hear, but some people may be able to detect tones as low as 15 Hz at very loud levels. Low-toned sounds can usually be felt as well as heard, and below 20 Hz the sensation usually changes completely from hearing to feeling.

It is not just the pitch, but also the loudness of a sound that determines what we can hear. Loudness, like pitch, is a perceptual phenomenon. While our perception of the pitch of a given tone corresponds to the frequency of the tone, our perception of the loudness of a tone corresponds to its intensity. Sound intensity, or power, is represented in decibels (dB), where higher dBs correspond to what we perceive as louder sounds.



Curves of equal loudness determined experimentally by Fletcher, H. and Munson, W.A. (1933) J.Acoust.Soc.Am. 6:59. Sourced from Prof. Joe Wolfe, Acoustics Lab, UNSW.

Although our absolute hearing range may be very large, our **functional hearing range** (those tones we can hear at sound levels of 30–70 dB) may be much smaller. A **hearing threshold** is the lowest sound level at which any given tone can be heard.

Hearing thresholds can be around 0 dB in humans at 1–4 kHz. This corresponds to the range that most speech sounds fall within. Outside of this range most higher and lower tones require 20–30 dB to be heard.

Hearing ability tends to gradually decrease with age. When hearing loss occurs with **age**, the higher frequencies are lost first. This makes it especially difficult to hear speech sounds at the beginnings and ends of words, such as ‘s’, ‘f’, ‘th’ and ‘sh’. Age-related hearing loss, called ‘presbycusis’, can occur from 35 years onwards, and tends to affect men more than women.

Extra for experts

In Australia, 16% of the population have some form of hearing impairment. Worldwide, it is estimated that over 50% of people aged over 60 years have some degree of hearing loss.

There are two main types of hearing loss:

- **Conductive hearing loss**: a mechanical problem affecting the conduction of sound to the inner ear. It is caused by damage, blockage or infection of middle or outer ear. This type of damage is **reversible**.
- **Sensorineural hearing loss**: a problem occurring in the inner ear due to injury or loss to the cochlea or nerves. This type of hearing loss is **permanent** and is more common in age-related hearing loss.

Exposure to **excessive noise** is the single most common cause of sensory hearing loss in Australia. Approximately 27% of hearing impaired people in Australia have a **noise-related** hearing loss.

An excessively loud noise is one where you have to raise your voice to be heard when standing at arms-length away. Loud noise, including loud music, can cause damage to the cochlear – even if there is no pain. Pain is not usually felt until 130 dB.

Australian Hearing lists the following degrees of hearing loss:

- **Mild**: 21–45 dB – some difficulty hearing soft speech.
- **Moderate**: 46–-60 dB – difficulty understanding conversational speech.
- **Moderately severe**: 61–75 dB – clarity of speech affected.
- **Severe**: 76–90 dB – normal conversational speech inaudible.
- **Profound**: 91 dB – varies from being able to understand face-face conversation while wearing a hearing aid to not hearing being able to at all.

Helpful terms

Frequency: The number of times a vibration occurs in one second (hertz or Hz). Fast vibrations have high frequencies and produce high notes.

Hertz (Hz): Hertz are the number of cycles a wave completes in one second. 200 Hz means the wave completes 200 cycles per second.

Intensity: Power per square metre carried by a sound wave; often measured in decibels (dB).

Pitch: The pitch of the tone is how high or low it seems. Pitch, like loudness, is a perceptual phenomenon and corresponds to frequency. High pitches have high frequencies.

Further information

We would like to extend our special thanks to Warwick Williams from the National Acoustic Laboratories of Australian Hearing for his assistance with information and images.

Human hearing ranges and abilities:

- Australian Hearing http://www.hearing.com.au/
- *Musical Acoustics, 3rd edition*. D E Hall, 2002. Wadsworth Group (Brooks/Cole), California.
- *Measured Tones*. I Johnston, 2002. Institute of Physics Publishing, Bristol.
- *Musical Acoustics – some introductory pages*. Acoustics Lab, UNSW http://www.phys.unsw.edu.au/music/basics.html
- *From Sound to Synapse: Physiology of the mammalian ear*. C D Geisler, 1998. Oxford University Press, New York.
- A weakness for personal stereo. S Abdulla, 1999. *Nature Science Update*, 14 January.
- World Health Organisation http://www.who.int/archives/whday/en/documents1999/hearing.html
- Australian Association of the Deaf Inc. http://www.aad.org.au/index.shtml

Test your own hearing curve at:

- *Hearing Curves: Equal loudness tester*. Acoustics Lab, UNSW. http://www.phys.unsw.edu.au/~jw/hearing.html

Animal hearing ranges:

- *Hearing in Vertebrates: a psychophysics databook*. R R Fay, 1988. Hill-Fay Associates, Winnetka, Illinois.
- *The Evolutionary Biology of Hearing*. D B Webster, R R Fay and A N Popper (eds), 1992. Springer-Verlag, New York.
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