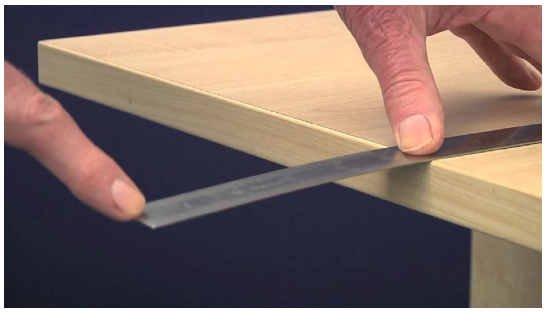
Sound: Additional Subject Knowledge

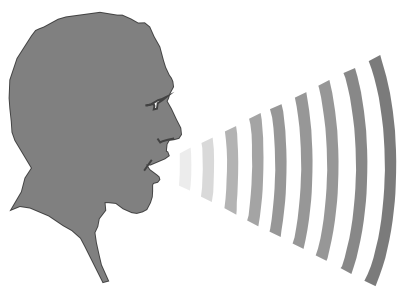
A sound is caused by a **vibration**, otherwise known as a **wobble**! It is good to use both words when this is first introduced. Sometimes this wobble or vibration can be seen and sometimes it is too fast to be seen.

Example where the vibration is slow enough to be seen:



- A ruler overhanging a desk made to vibrate – you can see it move and hear the resulting sound. N.B. Make sure you hold it tightly on the edge of the desk as in this picture.

When I speak, the air is made to vibrate which we cannot see. These vibrations travel through the air and reach your ears which detect the vibrations and send the signals to your brain which decodes them.



So, when we hear a sound, energy has travelled from the source of the sound to our ears. When sound travels through air it is rather like a domino effect. The 'bits' of the air (molecules) next to the source are made to vibrate and these then bump into the air molecules next to them which are also made to vibrate and so on until the vibrations reach the ear drum.

So, unlike light, sound does need something (a medium) in which to travel. It is possible to demonstrate this in secondary school with an alarm clock under a glass dome:

The alarm is made to ring and it can be heard through the glass dome. The air is then removed from inside the glass dome using a vacuum pump. The hammer is still hitting the bells on the clock but, as the air is removed, the sound fails to reach our ears. This is because sound can only travel when things are present to vibrate.

Interesting point: it is possible to ***see*** the alarm clock at all times, so **light can travel in a vacuum but sound cannot.**

'There is no scream in space!' This leads to the interesting fact that, on the surface of the Moon, where there is no atmosphere (i.e. there is no air), it is impossible for the astronauts to speak to each other normally. This is not just because their space suits muffle the sound but because the sound cannot travel through the vacuum that exists because there is no atmosphere.

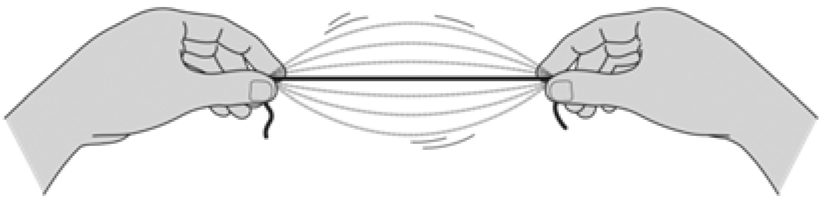
Whilst the astronauts on the Moon cannot speak to each other using normal speech, they are able to communicate with each other using radio transmission. Radio waves can travel in a vacuum. The astronaut speaks into a radio receiver in his space suit which converts the signal into radio waves that are transmitted through space to the other astronaut, and they are converted back to sound waves inside his space suit - hence he hears his friend!

Reflection of Sound

Echoes from large, flat surfaces, such as cliff faces, are examples of the reflection of sound. It is possible to find the distance to the bottom of the sea bed by echo-sounding which is the sending out of a very high pitched note from a transmitter in the hull of a ship and measuring the time it takes for the echo to return. Ultrasonic scanning of a baby in the womb is really just a sophisticated version of echo-sounding!

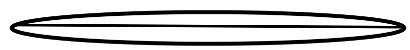
Volume

The volume (loudness) of a sound depends on the amount of air being made to vibrate. If an elastic band is plucked it vibrates backwards and forwards about its central position.

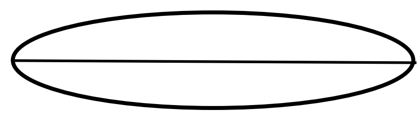


If it is plucked more strongly, it moves further from the central position and the size of the vibration is larger – more air is made to vibrate and so the sound is louder. The pitch of the sound is the same, it is just the volume that is altered.

An elastic band plucked gently makes a quiet sound



An elastic band plucked more strongly makes a louder sound



Similarly, if a drum is hit harder, the sound is louder – again the size of the vibration is larger and so more air is made to vibrate.

Pitch

A sound can be high pitched or low pitched. The pitch of a note is related to its frequency. Frequency means the number of vibrations per second. The faster that something vibrates, the higher the pitch of the sound.

This can be demonstrated with some secondary science equipment - a signal generator and a loudspeaker. When the sound produced is at a very low pitch, it is possible to see the cone of the loudspeaker moving. As the pitch rises, the cone vibrates faster and faster and soon moves too fast for our eyes to detect the movement at all – we still hear the sound though.

It is fun to find the range of frequencies which the human ear can detect. As we grow older this range lessens! Who can hear bats? It is also interesting to realise that doubling the frequency of a note results in the note being raised by exactly one octave.

Health & Safety:

Teachers always need to risk assess practical activities for their children and defer to their health and safety advisor for the most up-to-date source of health and safety guidance.

This training cannot be relied upon as source of health & safety guidance.

Sound: Teaching the Key Concepts

Sound is caused by a **vibration**, known in everyday language as a **wobble**! Use both words at first and then move to using only the scientific term, 'vibration'. Sometimes this vibration can be seen or felt and sometimes it is too fast for this to be possible.

Demonstrations:

Sound travels in air

- Demonstrate how to place your hand on your throat and feel the vibrations of your voice box as you speak. Then the pupils can do it too so that they feel the vibrations as they speak.
- By speaking we make the air vibrate but we cannot normally see this. However, if you (very carefully and warning them not to do this themselves!) hold a candle in front of your mouth as you speak, it can be seen flickering backwards and forwards. This is because sound is made by something vibrating and, in this case, the 'bits' of air (the molecules) are made to vibrate.
- Place a drum (if you don't have one, stretch a balloon across a circular tin and tape in place) on a stand close to, but not touching, a speaker that can blast out some loud music. Place some loose tea leaves or rice on top of the drum. Music with a strong beat is perfect and when it is played, the bits of tea or rice will be seen to 'dance'! The speaker makes the air vibrate, this in turn makes the drum and the material on top of it vibrate and we can see it move.
- Big ears**:** Make big cones with paper. Place them as close as possible to your ears and compare your hearing with and without them. Can you explain? Think about which animals have large ears and why.

Pitch and volume

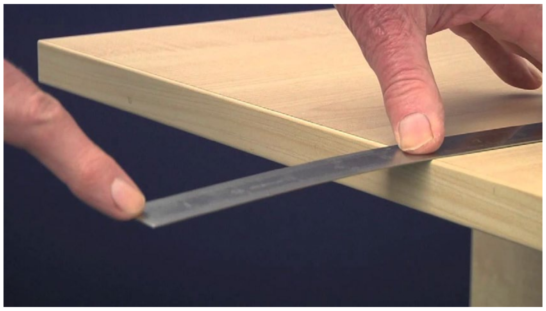
It is important to help children understand the difference between pitch and volume. This is not always at all obvious to primary children.

Demonstration: You can do this by singing:

- high and low notes - pitch
- loud and quiet (soft) sounds - volume

More examples:

A ruler overhanging a desk is made to vibrate by pulling down on it and letting go. – you can see it move and hear the resulting sound. N.B. Make sure you hold it tightly on the edge of the desk as in this picture:



Practical: This can be turned into a pupil investigation where they find out what changes the pitch of the sound produced. It is an excellent opportunity for the learning objectives to focus on drawing conclusions, as well as the development of their content knowledge. The intention is that they understand that the shorter the ruler, the higher the pitch (or vice-versa).

Musical Instruments

Similarly, all musical instruments produce a sound by causing a vibration.

This can be as a result of:

- something being struck - a drum or a saucepan lid or whatever.
- a string being plucked or bowed - elastic bands stretched across a box, a guitar, a violin etc.
- an air column being made to vibrate - blowing across the top of a bottle, or into a recorder, or flute, etc.

Illustrative practicals develop or reinforce pupils' understanding – they illustrate the subject knowledge that is being learnt. As this is the sound part of the curriculum, brace yourself for noise! It is good to have a range of the above for them to investigate. The learning objective can be focused on them explaining how the sound is made in each case.

Practicals: They can also be turned into pupil investigations, where they find out what changes the pitch of the sound produced as elastic bands are plucked, or bottles with different amounts of water in are blown across etc.

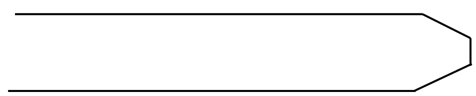
Demonstration:

If you or any of your colleagues play a musical instrument, the pupils can be asked to suggest how the sounds are changed as you play, i.e. how the pitch is changed, can the volume be changed?

For example, you can use a guitar to show that the pitch of the note depends on the length of the string and also on the thickness of the string. You can also show that plucking the string gently produces a quiet sound and plucking it more forcibly produces a louder sound.

Demonstration/a Practical Prompt for Thinking

Prepare a straw: cut it into a length of about 20cm and then cut one end into this shape:



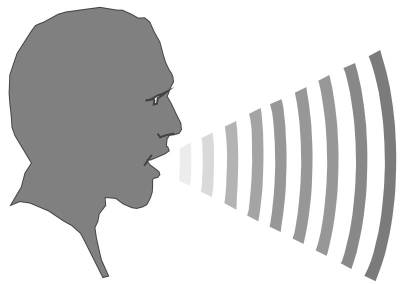
This requires practice! Place the cut end of the straw into the ***middle*** of your mouth. Close your lips around the straw and blow. You are not trying to blow down the straw itself – keep the end of the straw in the middle of your mouth, seal your lips tight and blow hard! If you keep trying, you will find that you can make an impressive sound – oboe players should find this easy!

Once you have mastered this, you can keep blowing whilst using scissors to reduce the length of the straw. Ask the pupils to explain what they hear.

If you can manage this, it is a great demonstration – the pitch increases as the straw is cut shorter and shorter.

A simulation – acting it out

When we speak, the air is made to vibrate. These vibrations travel through the air and reach your ears which detect the vibrations and send the signals to your brain which decodes them.



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A group of pupils can act this out by standing in a row, with the last person next to the classroom wall:

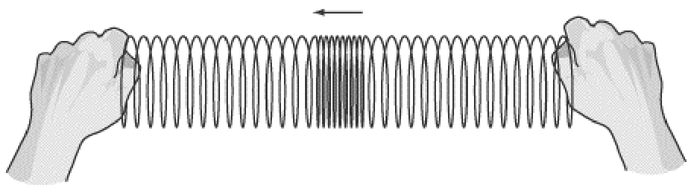
The person at the end of the row wobbles backwards and forwards, knocks (gently!) the person next to them who wobbles backwards and forwards, knocks the person next to them… and so on until the vibration has travelled all along the line. This takes time and so you can see that sound also takes time to travel from one place to another.

Reflection of Sound

When the vibration has moved all along the line of people, it reaches the classroom wall and will 'bounce' off it, causing the vibration to travel back in the other direction. This is an echo. Echoes from large, flat surfaces, such as cliff faces, are examples of the reflection of sound.

Demonstration

A slinky is also good for showing how sound travels



The coils of the slinky can be made to vibrate back and forth and you can see the coils bumping into each other. The air molecules vibrate back and forth, just like the coils of a slinky, when the sound travels through the air.

Sound travels not just in air:

Because sound is caused by a vibration, something needs to vibrate so it needs something in which to travel (a medium). This can be air, but sound can also travel in other things, such as string, water, metal etc.

Illustrative practical:

The pupils do the following:

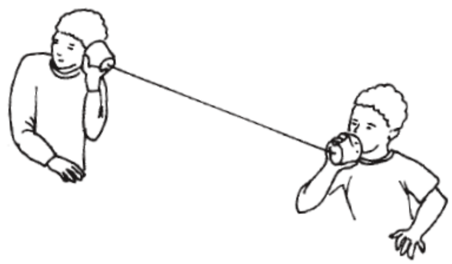
- Coat hanger (or spoon/slinky) and string in ears

Tie string onto a metal coat hanger, hold the ends of the string right next to your ear. Let the coat hanger swing and bang into a hard surface, such as a table. The sound produced is great! It travels through the string into your ears.

And/or tie one piece of string onto a metal spoon and have the other end next to your ear.

Even better, have two lengths of string: one tied to each end of a slinky. Hold the ends of the string right next to your ears, jump up and down so that the slinky bangs into the floor and vibrates.

- The string telephone - N.B. The string needs to be tight for this to work



It is important for all pupils to experience using a string telephone.

- Hearing under water - children in swimming pools, 'The Whales' Song' etc.

Data logging

The loudness of sound is measured in Decibels and increasingly primary schools have data logging equipment linked to the computer which allows measurements of sound levels to be recorded and monitored. It is a great demonstration to use the interactive whiteboard to show a graph of volume against time being created by a data logger – as the children shout the graph goes up and when they are quiet it goes down. You can ask them to create a sound level which is half way up the scale etc.

You can also use a data logger to show that the intensity of sound decreases as the distance from the source of the sound increases or, more simply, a noise becomes quieter as you get further away from it!

A simpler way of doing this is to have some loud music playing and just walk further and further away from it.