**Waves & Radiation**

**Sound**

**Summary**

Sound is caused by **vibrations**.

Sound can travel through solids, liquids and gases, but not a vacuum.

**Wave Patterns**

Sound waves can be converted to electrical signals with a **microphone** and the wave pattern observed on an **oscilloscope**.

**low pitch**

**high pitch**

high pitch sounds have a greater frequency than low pitched sounds

(there are more waves)

loud sounds have a greater amplitude than quiet sounds

(the waves are higher)

**quiet**

**loud**



**Speed of Sound**

The speed of sound can be determined by dividing the distance travelled by a sound by the time taken to travel that distance.

Make a loud sound at X.

When the sound reaches microphone A the electronic timer starts and when sound reaches microphone B the timer stops.

Measure the distance between the microphones with a ruler.

**Indoors**

**X**

0·000293 s

microphone

A

microphone

B

electronic timer

Person A stands several hundred metres away from person B.

Person A closes the clapper to make a loud sound.

When person B sees the clapper close the stopclock is started and when they hear the clapper close the stopclock is stopped.

Measure the distance between person A and person B with a measuring tape.

**Outdoors**

person

A

person

B



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The speed of sound in air is around 340 metres per second, but is affected by factors such as temperature.

**Distance, Speed and Time**

m

m/s

s

*v*

*d*

*t*

Sound travels at different speeds in different materials (e.g. 1500 metres per second in water or 5200 metres per second in steel).

Calculations can be carried out for the speed of sound using the relationship between distance speed and time.

**Sound Levels**

Sound levels are measured in **decibels**, dB. The quietest sound that can be heard is 0 dB and is called the **threshold of hearing**.

Regular exposure to sound levels above 90 dB (e.g. pneumatic drills or heavy traffic) can cause damage to hearing. Workers exposed to sounds above this level should wear ear protectors.

**Ultrasound**

Ultrasound is sound with a **frequency** above the range of human hearing (above 20000 Hz).

An ultrasound scanner can be used to examine the inside of a patient (e.g. an unborn baby inside the mother’s womb). Sonar uses ultrasound to detect objects in water. In both systems the time taken for the ultrasound to reflect from objects is measured and, knowing the speed of sound in the medium through which the sound travels, the distances to the objects can be calculated and an image built up by a computer.

Ultrasound can also be used to shatter kidney stones.

**Sound Reproduction**

Sound waves can be converted to electrical signals with a **microphone**. These electrical signals can then be made stronger with an **amplifier** and converted back into (a louder) sound with a **loudspeaker**. The electrical signals can also be altered with electronics to change properties such as the relative amounts of high and low frequencies (bass and treble), the shape of the signal to alter the tone, or even the frequency to alter the pitch of the note (e.g. Autotune).

**Noise Cancellation**

Sounds can **interfere** with one another. In noise cancellation unwanted sounds are removed by ‘adding the opposite’ of an unwanted sound so that the sounds **interfere destructively**. Noise cancellation is used in aircraft cockpits and high quality headphones.