Lesson Fifteen

Sound

Aims

By the end of this lesson you should be able to:

- understand that sound waves are longitudinal waves and how they can be reflected, refracted ***and diffracted**
- understand that the frequency range for human hearing is 20Hz to 20000Hz
- describe an experiment to measure the speed of sound in air
- ***understand how an oscilloscope and microphone can be used to display a sound wave, and describe an experiment using an oscilloscope to determine the frequency of a sound wave**
- ***relate the pitch of a sound to the frequency of vibration of the source, and the loudness of a sound to the amplitude of vibration**

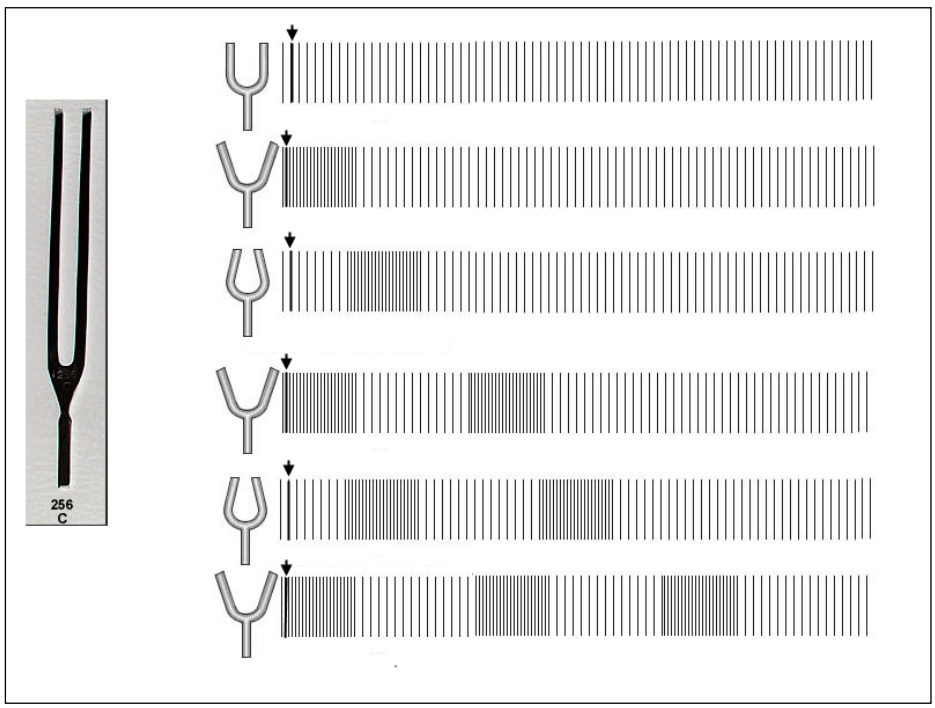
Context

This lesson covers sections 3.26-3.32 of the Edexcel IGCSE Physics specification.

Edexcel IGCSE Physics Chapter 14, pages 118 – 125.

Introduction

Sound waves are **compressions** and **rarefactions** (squashes and stretches) that travel through the air or other materials. During compression the air particles are squeezed closer together, while during rarefaction they are pulled further apart. Sound waves are produced by **vibrating** objects which produce these compressions and rarefactions as they move backwards and forwards.



Compressions and rarefactions moving through the air after being produced by a vibrating tuning fork.

Sound waves are **longitudinal** waves, unlike light which is a transverse wave. They can travel though all sorts of material (including solids, liquids and gases), but not through a vacuum because in that case there are no particles to compress.

Activity 1

An experiment demonstrating that sound cannot travel through a vacuum is shown on YouTube at

http://www.youtube.com/watch?v=q2pj9k1IrsM .

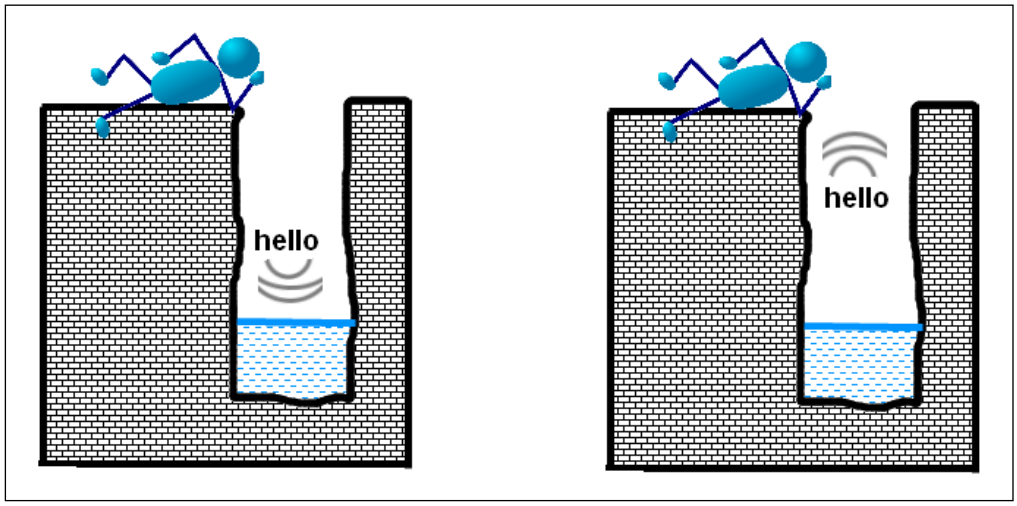
Alternatively, put "sound vacuum" into the YouTube search box.

Reflection, refraction and *diffraction of sound waves

Like all other sorts of wave, sound waves can be reflected, refracted and diffracted when they meet a boundary.

Reflection

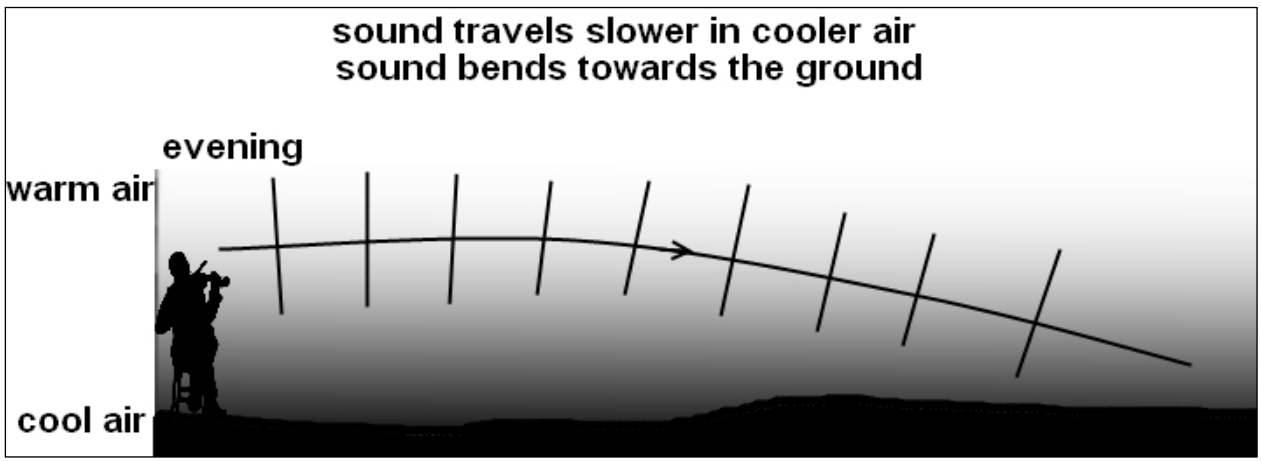
The reflection of sound causes echoes:



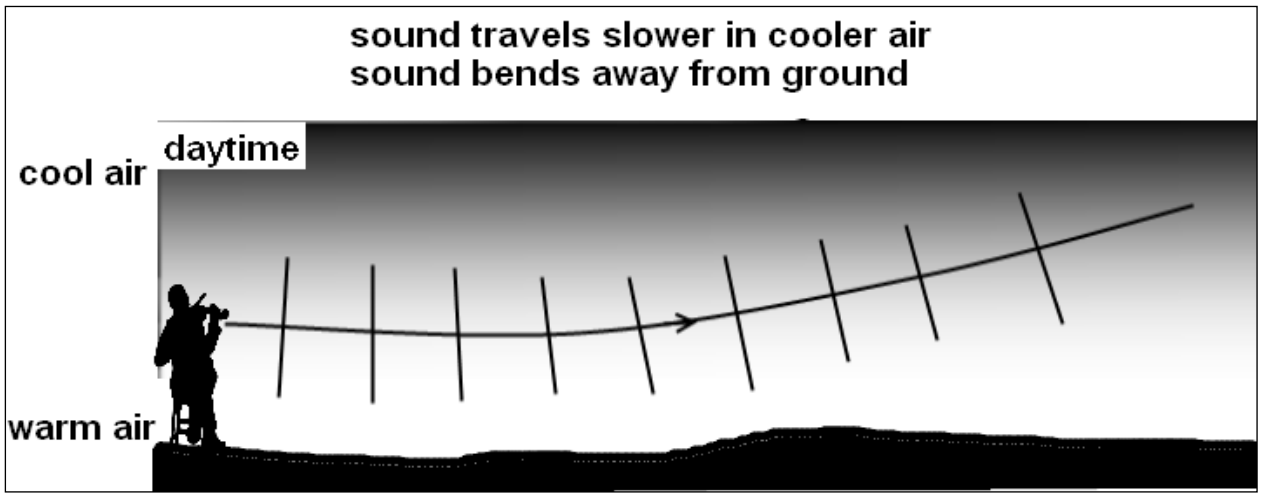
The investigation in figure 14.7 on page 120 of the textbook shows how to verify that sound waves obey *the law of reflection*.

Refraction

Sounds may be heard at a greater distance on a cool evening than on a warm evening, because when the air near the ground becomes cooler than the air higher up and the sound is refracted downwards.



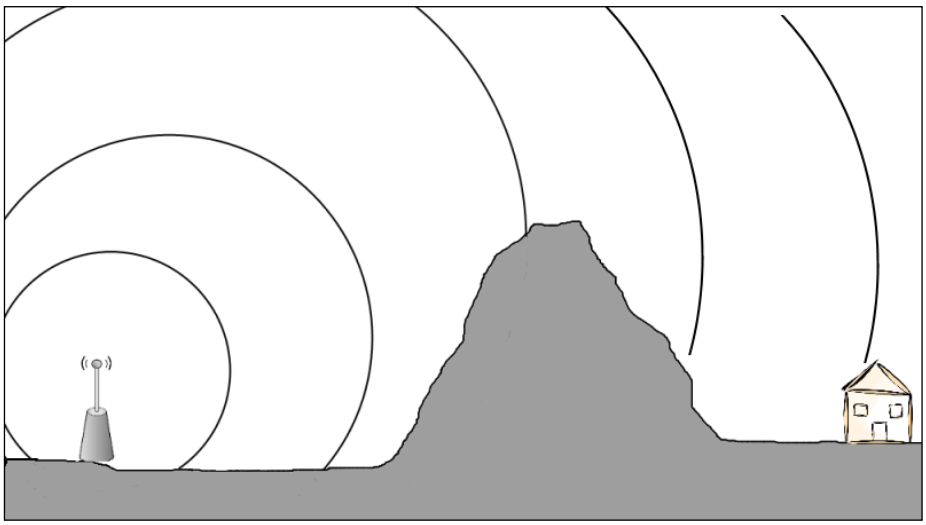
Sound refracted downwards



Sound refracted upwards

*Diffraction

Sound spreads within the 'shadow' of the edge of a building by diffraction. Sounds with longer wavelengths bend round an obstacle more than sounds with shorter wavelengths.



Barriers are erected alongside motorways to reduce sound pollution for the houses next to the motorway, but the rumble of engine noise may still be heard because the sound waves bend over the wall.

Activity 2

View the webpage at

http://www.onosokki.co.jp/English/hp_e/patio/kaisetsu.htm

or find by using the search phrase

Ono Sokki's patio diffraction sound Disneyland

Take note of the diagrams showing the longer wavelength sound waves reaching further round the sound wall than the shorter wavelength sound waves.

The range of human hearing

As for other waves, the frequency of sound waves is measured in Hertz (Hz), that is, the number of waves passing a fixed point per second.

Different animals are able to hear sounds with different frequencies:

Log on to Twig and look at the film titled: **Beyond Human Hearing**

www.ool.co.uk/1431bk

Humans can only hear a certain range of sound frequencies. Discover the sounds we can't hear and why they can be useful.

Humans hear sounds in the range 20Hz to 20,000Hz, which is called the **audible range**. This range decreases with age, especially at the higher end of the frequency range.

Sound above 20,000Hz is called **ultrasound**. Ultrasonic dog whistles produce ultrasound that has a frequency higher than 20,000Hz and can be heard by dogs but not by humans

Activity 3 	The Mosquito Deterrent Device View the webpage: http://www.movingsoundtech.com/ or search for the phrase ***MST featuring The Mosquito Device***
	The device is not designed to deter mosquitos but to deter people who are young enough to hear its high pitched sound. At the bottom of the webpage you can try out sounds of different frequencies.

Measuring the Speed of Sound in Air

The speed of sound in air is approximately 340m/s , although this varies a little with air temperature and pressure. For comparison, the speed of sound in seawater is about 1500m/s, and through rock is even faster.

	Log on to Twig and look at the film titled: **Speed of Sound** www.ool.co.uk/1429hq Sound waves move through different mediums at different speeds, but why is this? What factors affect the speed of sound?

There are two simple methods for measuring the speed of sound in air.

Using an echo

Find a place where an echo can be heard clearly. Measure the distance to the reflecting surface with a tape measure. Get a friend to clap. Using a stopwatch, measure the time between the clap and hearing the echo.

To improve the accuracy of the method, get the friend to clap rhythmically, so that the second clap happens at exactly the