LONGITUDINAL WAVES AND SOUND 08 APRIL 2014

Lesson Description

In this lesson we:

- Define longitudinal pulses and waves
- Revise the properties of sound
- Solve problems relating to sound waves

Summary

Transverse Pulses

PhET Simulation

- http://phet.colorado.edu/sims/wave-on-a-string/wave-on-a-string_en.html

A **medium** is the substance or material through which a pulse or a wave moves.

A **pulse** is a single disturbance which moves through a medium.

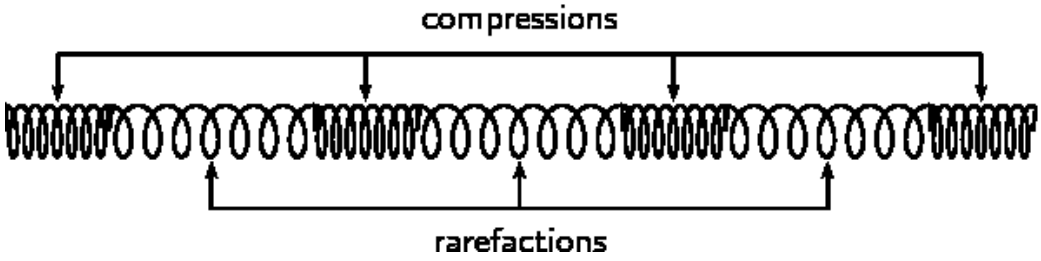
A **transverse** pulse is formed in a medium when all the particles disturbed by the pulse move perpendicular (at a right angle) to the direction in which the pulse is moving.

A longitudinal pulse is formed in a medium when all the particles disturbed by the pulse move parallel to the direction in which the pulse is moving.

The **amplitude** of a pulse is a measurement of how far the medium is displaced momentarily from a position of rest.

A **compression** is a region in a longitudinal wave where the particles are closest together.

A **rarefaction** is a region in a longitudinal wave where the particles are furthest apart.



The **wavelength** in a longitudinal wave is the distance between two consecutive points that are in phase. i.e. between two consecutive compressions or between two consecutive rarefactions.

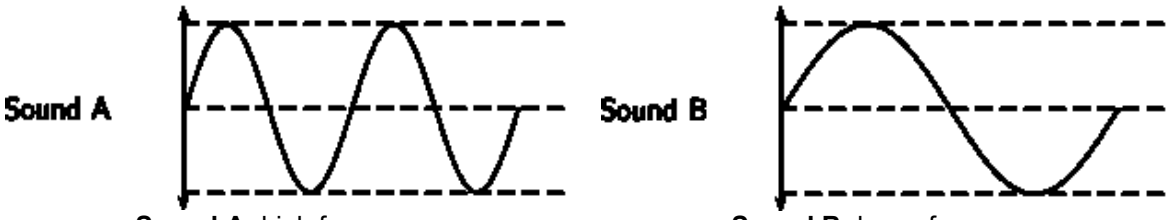
Sound

When a source of the sound vibrates it creates regions of high pressure and regions of low pressure.

Speed of sound waves depends on the medium.

- Phase:
  Solids: particles are closer together – therefore sound waves move fastest in solids.
- Temperature:
  Higher temperature – particles move faster, higher kinetic energy – therefore sound waves move faster.
- Air pressure:
  Higher air pressure– therefore waves move faster found at sea level where air is denser.

Pitch of sound relates to the **frequency** of the sound wave. e.g middle "C" is 256 Hz. The higher the pitch the higher the frequency.

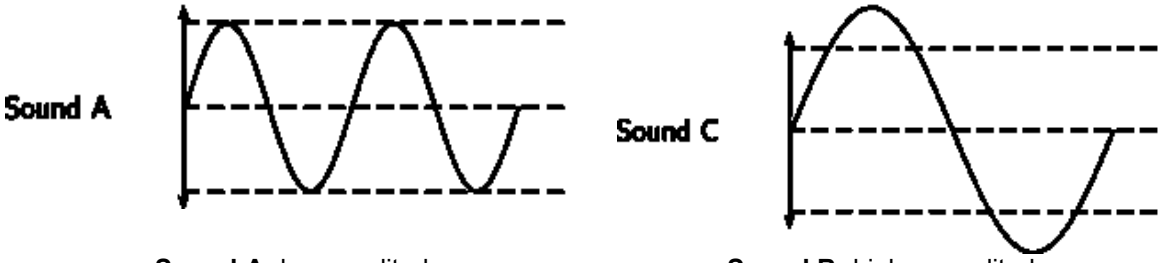


Sound A: high frequency

Sound B: lower frequency

The human ear can detect a wide range of frequencies. Frequencies from 20 to 20 000 Hz are audible to the human ear. Any sound with a frequency below 20 Hz is known as an infrasound and any sound with a frequency above 20 000 Hz is known as an ultrasound.

Loudness of sound relates to the **amplitude** of the sound wave. The higher the amplitude the louder the sound.



Sound A: low amplitude

Sound B: higher amplitude

Test Yourself

Question 1

The unit Hertz is equivalent to...

A s^{-1}

B s

C $m^{-1}.s$

D $m.s^{-1}$

Question 2

The speed of a wave is found by

A wavelength ÷ frequency

B frequency ÷ wavelength

C wavelength x frequency

D wavelength x period

Question 3

The sound that has the highest pitch has ...

A a frequency of 500Hz and an amplitude of 50 dB

B a frequency of 450Hz and an amplitude of 75 dB

C a frequency of 400Hz and an amplitude of 100dB

D a frequency of 300Hz and an amplitude of 120dB

Question 4

The sound that is the loudest is ...

A a frequency of 500Hz and an amplitude of 50 dB

B a frequency of 450Hz and an amplitude of 75 dB

C a frequency of 400Hz and an amplitude of 100dB

D a frequency of 300Hz and an amplitude of 120dB

Question 5

An echo is evidence that sound waves can

A interfere with each other

B undergo diffraction

C be reflected

D be refracted

Question 6

Select one of the words or phrases listed below that matches the following descriptions:

wave **pulse** **wavelength** **reflection**

frequency **interference** **medium** **period** **amplitude**

a. A single disturbance in a medium

b. The distance of one complete wave measured between any two adjacent points in phase.

c. The maximum disturbance of the medium from rest.

d. The time taken for one complete wave to pass a point.

e. The combination of sound from two sources that produces a louder sound

Improve your Skills

Question 1

A guitar string produces a musical note, E, that travels through air at a speed of 330 $m.s^{-1}$. The frequency of the note is 329,6 Hz. Calculate:

a. The period of the note.

b. The wavelength of the note.

A different string on the guitar also a note with a frequency of 82,41Hz

c. What can you deduce about these two notes?

Question 2

A teacher uses a signal generator to produce sound waves which have a frequency of 10Hz and a wavelength of 40m in air. The signal generator is attached to an oscilloscope. A wave pattern is displayed on the screen with an amplitude of 2cm. The oscilloscope shows is adjusted to show 2,5s.

a. Draw a sketch graph showing what you would see on the screen.

b. On the same set of axes, draw a graph showing a wave that has double the amplitude and half the frequency

c. Calculate the speed of the sound wave

d. Predict what will happen to the speed of sound when

   i. the sound moves from air into a steel bar

   ii air that is 5^0 cooler