REVISION: WAVES 29 APRIL 2014

Lesson Description

In this lesson we:

- Revise how to solve wave problems

Summary

Transverse Pulses

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

A **transverse** pulse where all of the particles disturbed by the pulse move perpendicular (at a right angle) 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.

The **pulse length** is a measurement of how long the pulse is.

The **principle of superposition** states that when two disturbances occupy the same space at the same time the resulting disturbance is the sum of two disturbances.

Constructive interference takes place when two pulses meet each other to create a larger pulse. Could be two crests meeting or two troughs meeting.

Destructive interference takes place when two pulses meet and result in a smaller amplitude disturbance.

Transverse Waves

A **wave** is a periodic, continuous disturbance that consists of a train of pulses.

Note: There is no net displacement of the particles of the medium (they move up and down and return to their equilibrium position), but there is a net displacement of the wave.

A **crest** is a point on the wave where the displacement of the medium is at a maximum.

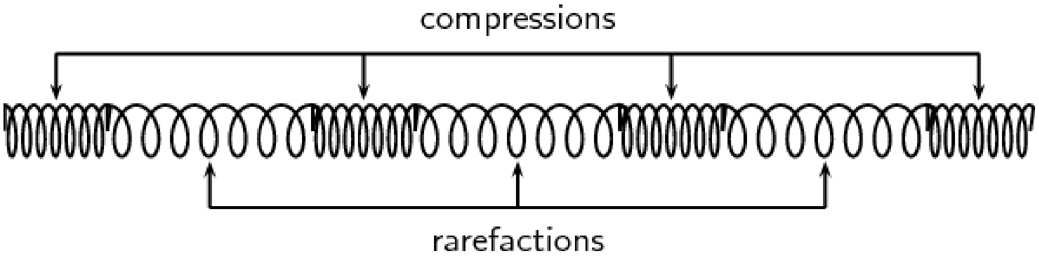
A **trough** is a point on the wave where the displacement of the medium is at a minimum.

Longitudinal Waves

A **longitudinal wave** is formed when all the particles disturbed by the wave move parallel to the direction in which the wave is moving.

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.

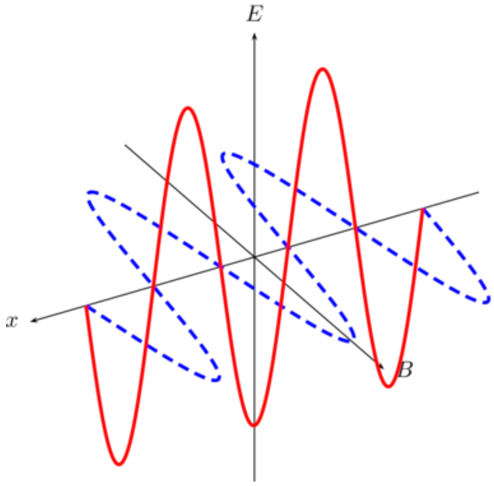
Pitch of sound relates to the **frequency** of the sound wave. e.g middle “C” is 256 Hz. The higher the pitch, the higher the frequency.

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

Electromagnetic Spectrum

Visible light – only a part of a whole range of radiation that our eyes cannot detect.

Made up of changing electric and magnetic fields interacting.



Picture taken from: www.everythingscience.co.za

Properties:

Travel at a constant **speed** of 300 000 000 m.s^{-1} or **3 x 10 ^{8} m.s^{-1}** in a vacuum.

No medium is required for EM radiation to pass through.

Wave particle duality – behaves like a wave and a particle.

Improve your Skills

Transverse Pulses & Waves

Question 1

A boat, out on the ocean experiences waves (swells) passing, lifting it 8 m from trough to crest. Waves pass every 7 s and are a measured distance of 10 m apart from crest to adjacent crest.

a.) What is the amplitude of the waves?
b.) Calculate the frequency of the waves.
c.) Assuming none of the conditions change, how long will it take for these waves to reach the shore 24 km away?

Question 2

Two pulses move towards one another. Pulse 1 has amplitude of 5 cm and moves from left to right. Pulse 2 has amplitude of -3 cm and moved from right to left.

a.) Draw a sketch to indicate these pulses relative to one another.
b.) Identify the type of interference that will occur when the pulses meet. Provide a reason for your answer.
c.) Calculate the amplitude of the resulting pulse when the two pulses meet.
d.) Draw a sketch indicating what happens to the pulses when they have passed one another.

Longitudinal Waves & Sound

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

Electromagnetic Radiation

Question 1

Two forms of radiation are given:

A. EM radiation with a frequency of 0.5 THz
B. EM radiation with a wavelength of 890 µm

a.) Calculate the energy of a photon of each form EM radiation.
b.) Compare the forms of radiation in terms of which has the longer wavelength?

Question 2

X-rays are part of the electromagnetic spectrum. It is given that the wavelength of certain X-rays are 2.3 nm.

a.) Calculate the frequency of the X-rays.
b.) Determine the energy of a photon of this X-ray radiation.
c.) Suggest a medical use of X-rays.
d.) Discuss the penetrating ability of X-rays.
e.) What precautions would medical personal operating X-ray machines need to take?

Links

PhET Simulation

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