Contents

1. General Wave Properties

Definition:

Question:

What actually do waves do?

Answer:

It provides a mechanism for the *transfer of energy* from one point to another without *physical transfer of any materials*.

Wave Sources

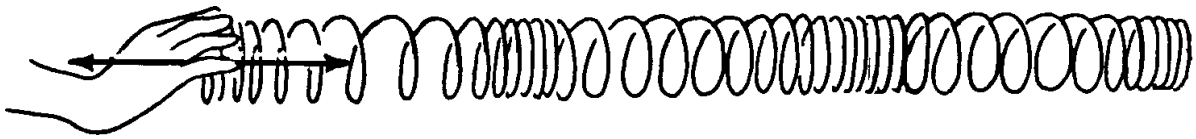
Waves are produced if there are any _____.

Types of Waves

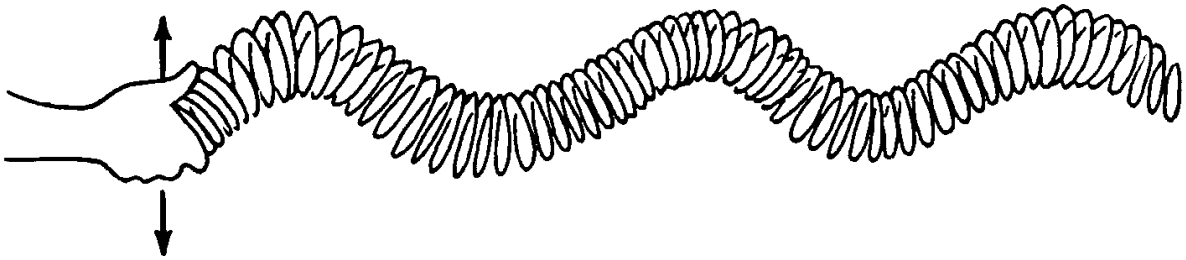
There are basically 2 types of waves - transverse and longitudinal.

They differ in their _____

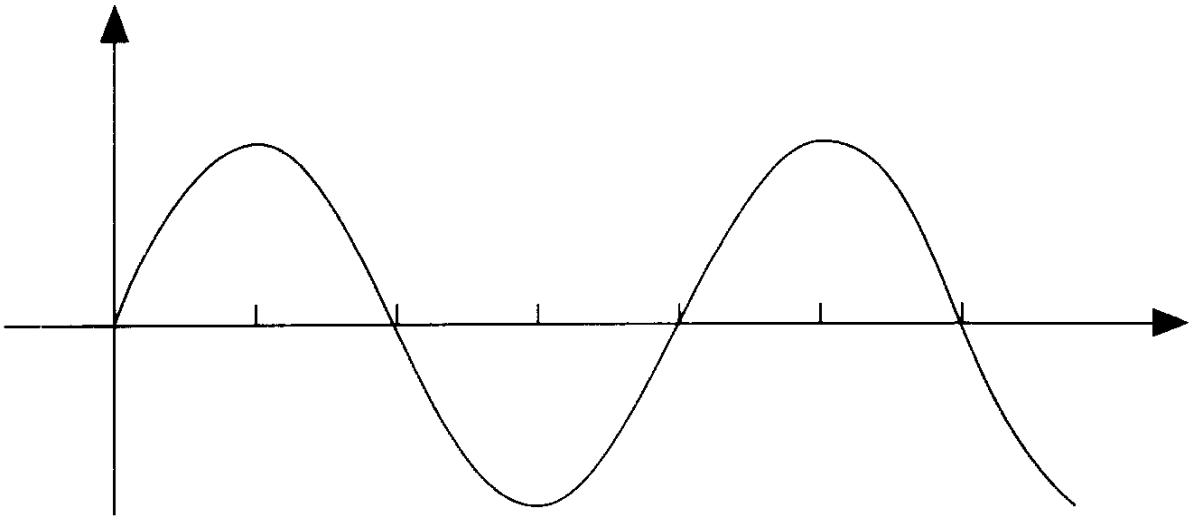
Longitudinal waves:



Transverse waves:



Describing Waves



Wave Terminology

1. Amplitude, A:

2. Wavelength, λ:

3. Crests and Troughs:

4. Phase:

5. Frequency, f:

6. Period, T:

7. Wave speed, v:

8. Wavefront:

Questions:

1. a) Fig (i) shows the graph of the variation of the displacement of a wave with distance along the wave at a particular time.

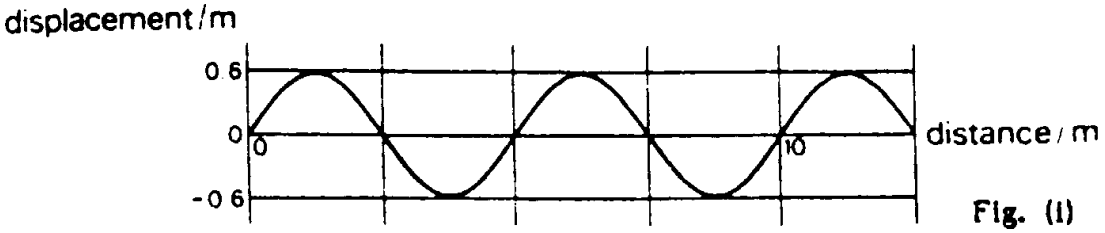


Fig. (i)

State values for

(i) the amplitude of the wave = cm

(ii) the wavelength of the wave = cm

b) Fig (ii) shows the graph of the variation of the displacement of a wave with time at a particular point along the wave.

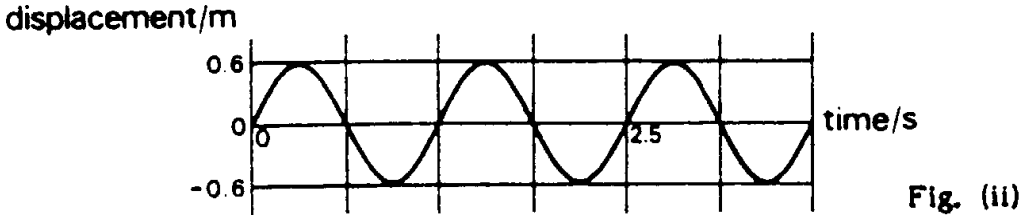


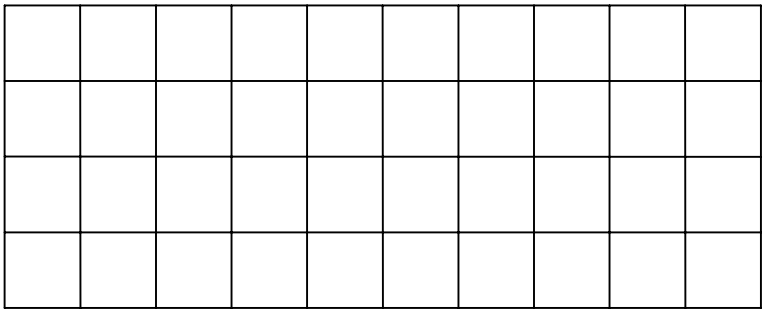
Fig. (ii)

State values for

(i) the time for one complete cycle = s

(ii) the frequency of the wave = Hz

2. Draw on the grid below a transverse wave at a particular instant as it travels from left to right. Your wave should be drawn full scale and should have an amplitude of 2.0 cm and a wavelength of 5.0 cm.



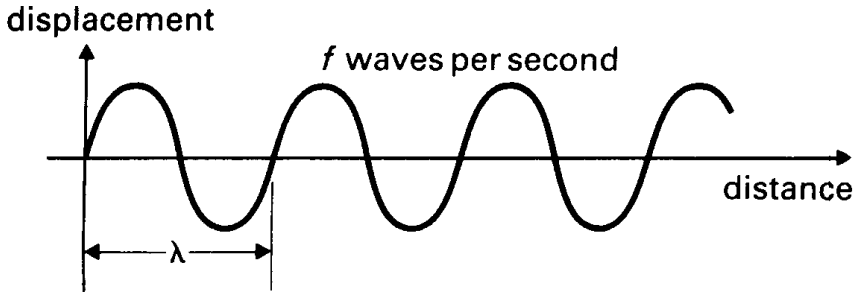
Note:

Always check the axes of the graph and analyse what you are given. Do not jump to the conclusion that the X-axis is always *wavelength* for they may give you *period*.

The Wave Equation

Remember that speed can be found from the equation:

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$



For waves,

v =

But,

f =

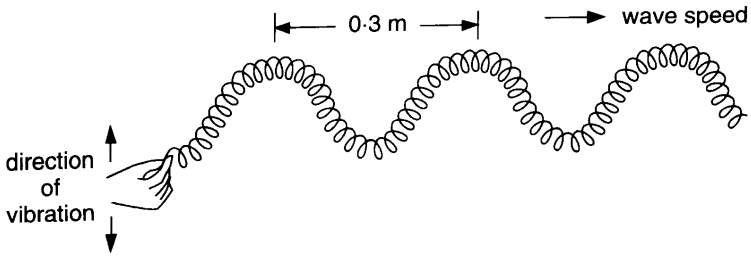
Therefore,

v =

v	- velocity (m/s)
f	- frequency (Hz)
λ	- wavelength (m)

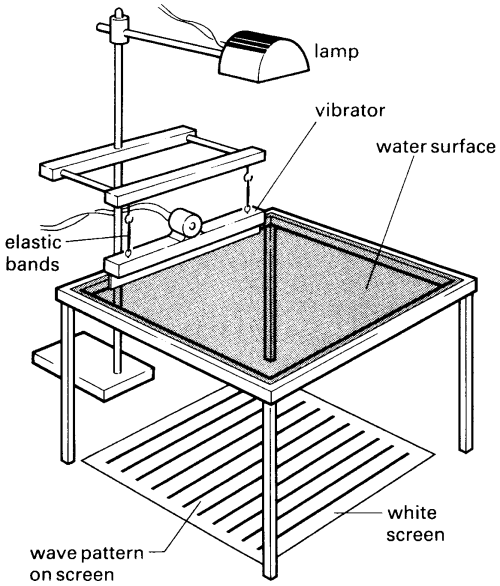
Examples:

1. A wave moves with a frequency of 3 Hz and a wavelength of 0.3 m. What is the speed of the wave?



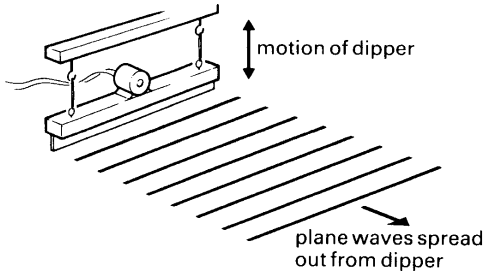
2. The speed of green light of wavelength 0.6 μm in a vacuum is 3.0×10^8 m/s.
   a) Calculate the frequency.
   b) Calculate the period of the wave.

Wave Production and Ripple Tank

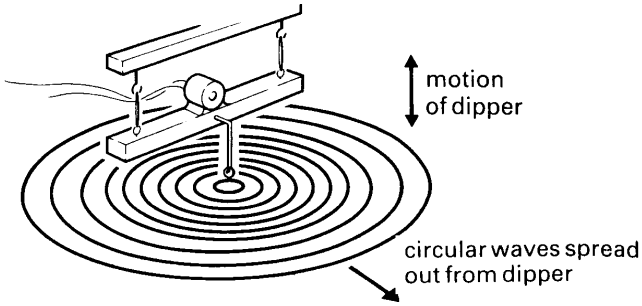


- Screen below water tray is used to capture image of waves produced.

- The Ripple Tank consists of a shalow glass-bottomed tray, a light source directly above the tray and a white screen below.
- Waves formed by a vibrator bobbing up and down.

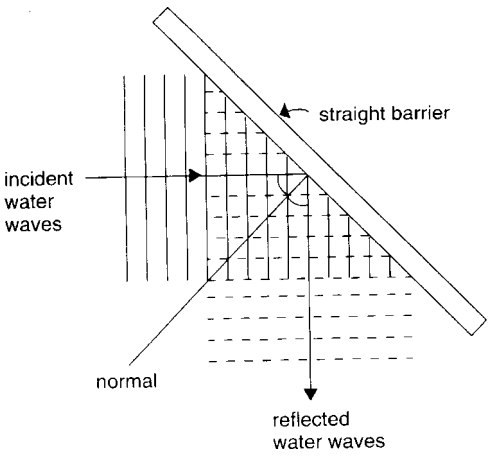


- Waves formed can be plane waves or circular waves.



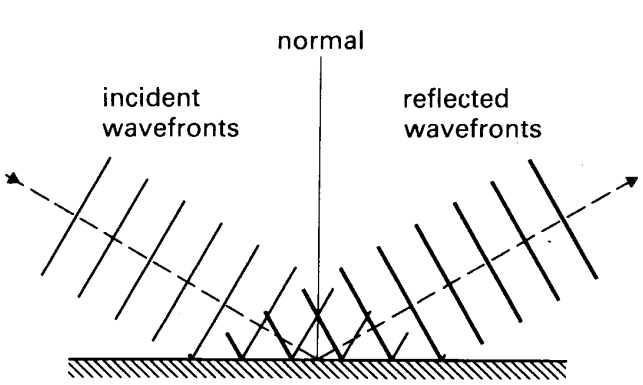
The apparatus is used to investigate waves travelling through water.

Reflection of Waves

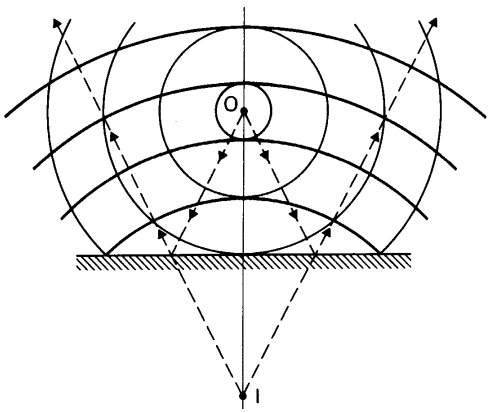


What do you notice about the incident and reflected angles?

Note:
When water waves get reflected, the only thing that changes is the *direction*.
Wavelength and *frequency* are the same throughout.



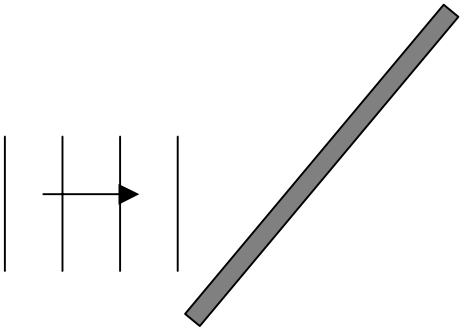
Plane waves reflected from a plane surface

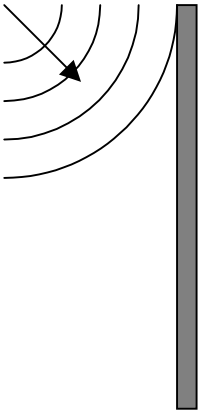


Circular waves reflecting from a plane surface

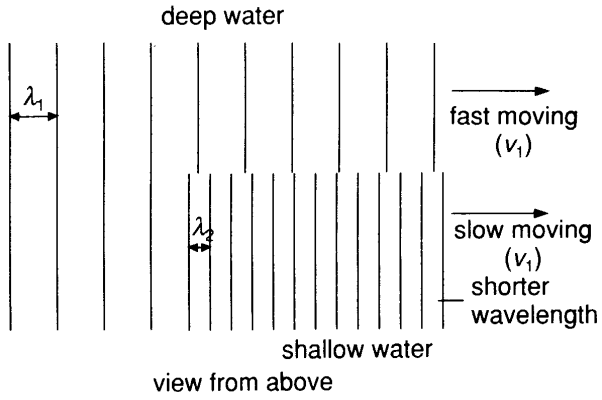
Questions:

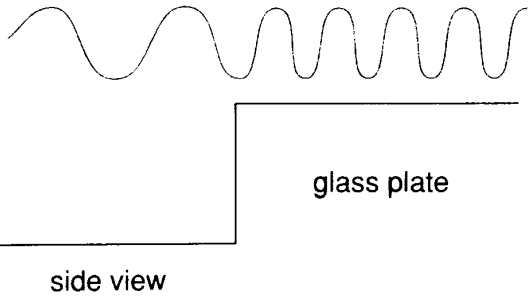
Complete the diagrams to show the wavefronts that would be reflected from the following barriers.





Effect of Water depth on Waves





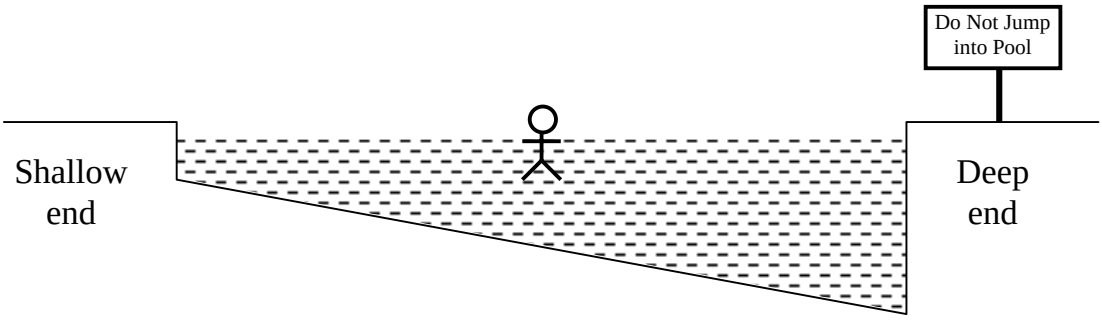
In moving from deep to shallow water the water,

the waves will move with a _____ speed,

the waves' wavelength will become _____ ,

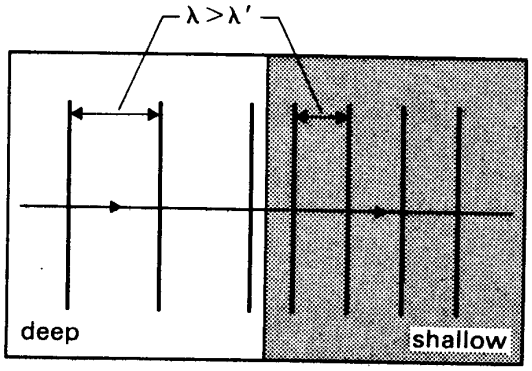
the frequency of the waves will _____.

Show the waves on the swimming pool caused by a boy jumping into the middle of the pool.

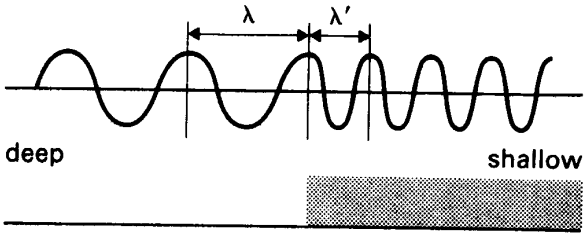


Refraction of Waves

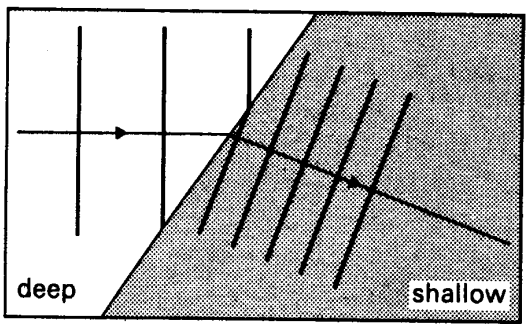
Refraction of water waves occurs when waves move from deep water to shallow water (or vice versa). As with light it is brought about due to the different speeds of the waves passing through differing media.



a) We have already seen waves entering a region of shallow water will be slowed down.



b) Seen from the side view the change in wavelength can be seen more clearly.



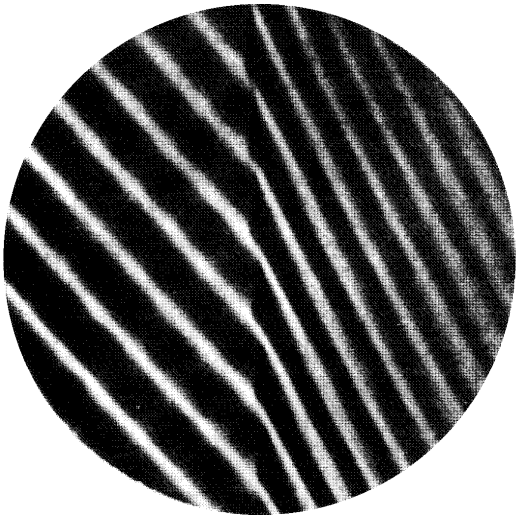
c) In a similar way to light slowing down as it enters a different media this will result in the water waves bending **towards** the normal as they pass from deep to shallow water.

Note:

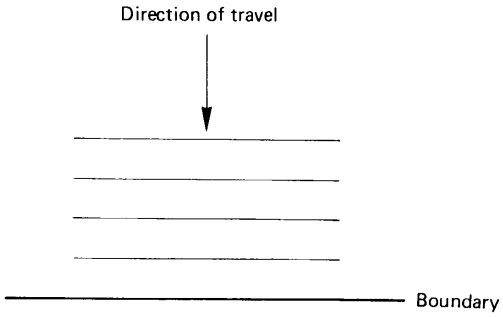
Wavelength and *speed* changes for this case.
The *frequency* of the waves stays the same.

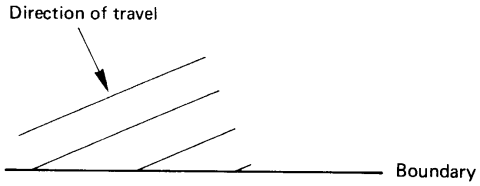
Questions:

1. Identify the shallow and deep water as shown on this photo of waves taken from a ripple tank.

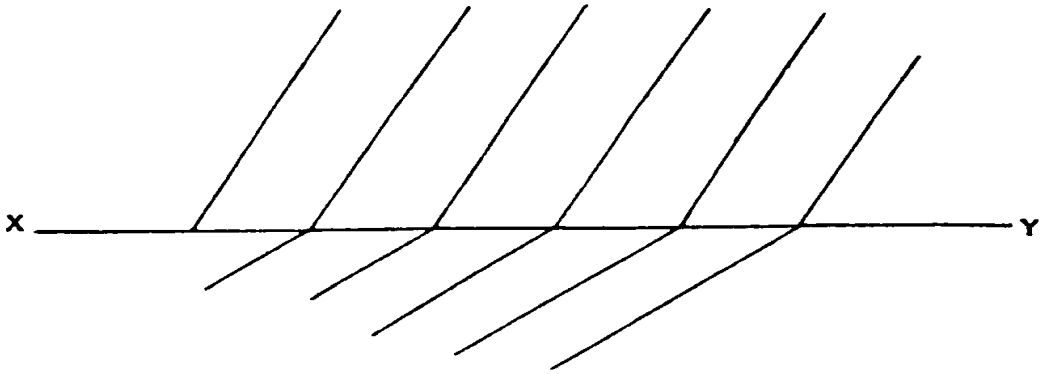


2. The following diagrams show three wavefronts passing from shallow water into deep water. Complete the diagram to show the direction of the wavefronts after crossing the boundary.



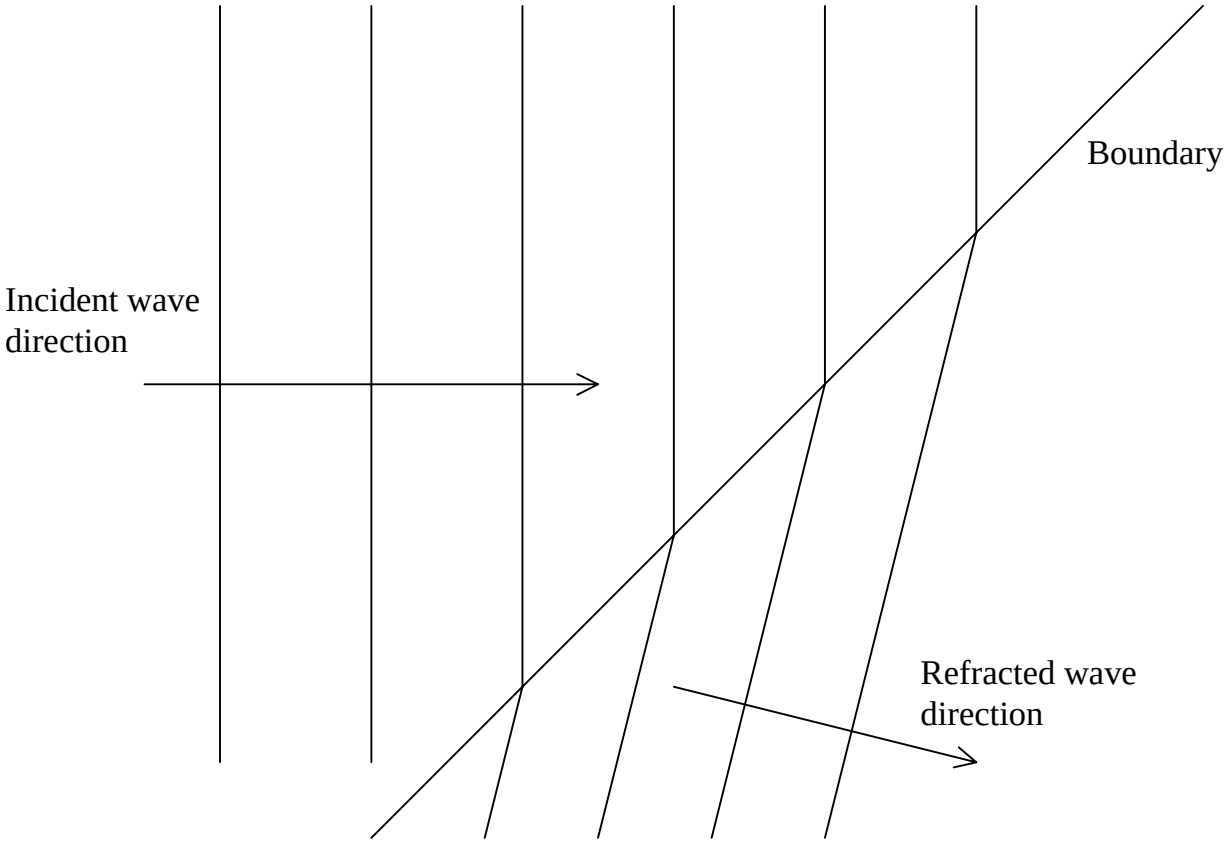


3. a) On the diagram below show the direction of the wavefront as it passes over the boundary **XY**.



b) Is the wave passing into deeper or shallower water?

4. In the full scale diagram below, the unlabelled lines represent successive wave crests. Refraction of plane waves occurs as the waves cross a boundary. The frequency of the waves is 6.0 Hz.



What is

a) the speed of the incident waves,

b) the frequency of the refracted waves,

c) the wavelength of the refracted waves,

d) the speed of the refracted waves?

e) Given that the angle of incidence of the waves at the boundary is 45º, from the diagram, using a protractor, determine the angle of refraction. Hence or otherwise find the refractive index at the boundary.

2. Electromagnetic Waves

Often referred to just as EM waves.

Properties of the Electromagnetic Waves

The following properties applies to the electromagnetic wave:

1. What type of waves are they?

2. Do they require a medium to travel through?

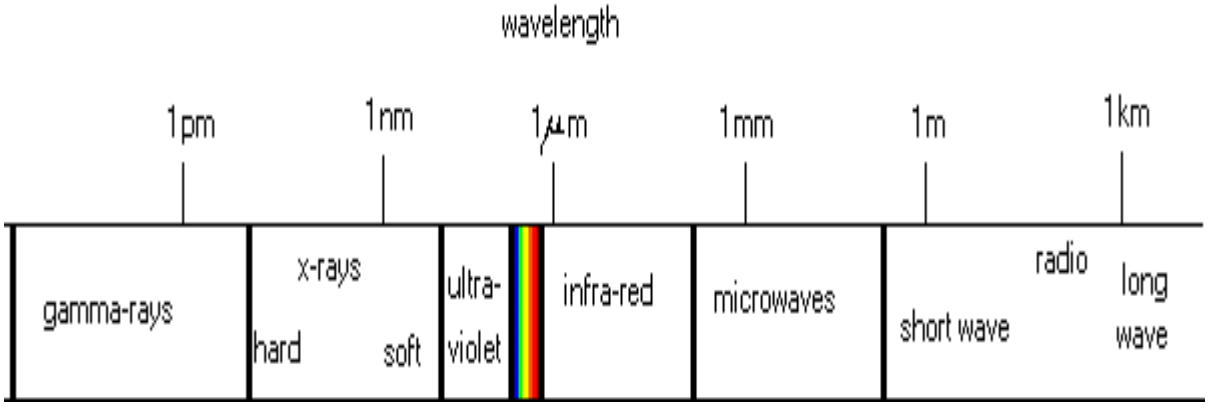
3. How fast do they travel?

4. They can all be _____ or _____ (like visible light).
5. They can be _____ and _____ by matter.
6. They all obey the wave equation, $v = f\lambda$.
7. Their frequencies do not change as they pass from one medium to another. However, both their speed and wavelength will change.
8. They carry _____ from one place to another.

Electromagnetic Spectrum

- The whole range of EM waves are arranged in a particular order, from the shortest wavelength to the longest wavelength:

  Gamma rays, X-rays, Ultraviolet, Visible, Infra-red, Microwaves, Radiowaves



Application of Electromagnetic Waves

Radiowaves:

Ultraviolet (UV):

Microwaves:

X-rays:

Infrared (IR):

Gamma Rays (γ):

3. Sound

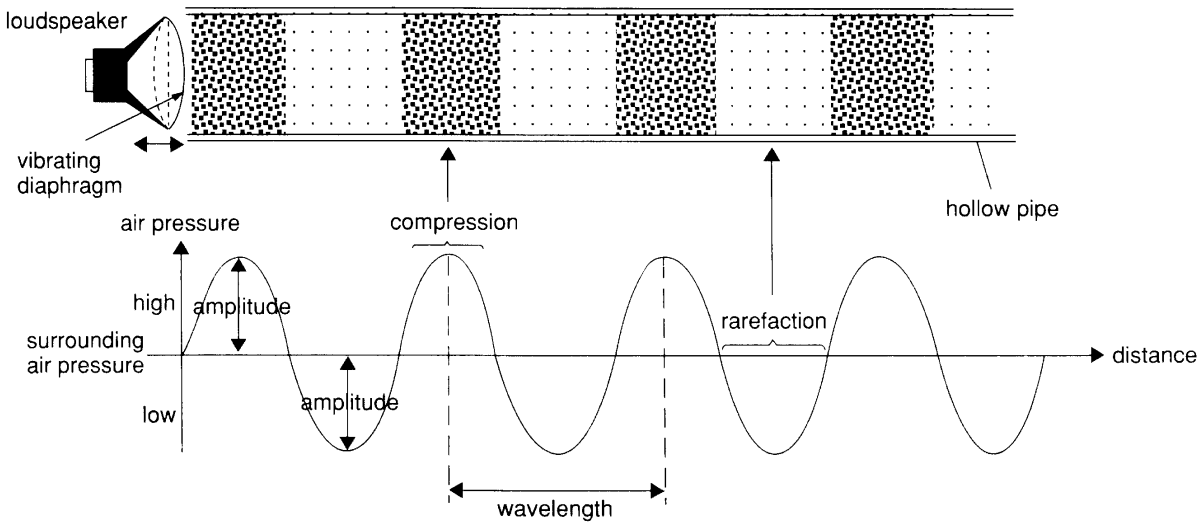
Definition/Notes:

Compression & Rarefaction

Sound is caused by changes in air pressure.

Compression:

Rarefaction:



Note:

Look at the axes of the graph. In sound, it is always pressure versus distance.

Can we still use the Wave Equation for sound?

The formula $v = f\lambda$ still applies in sound

v : velocity of sound (m/s)
f : frequency of the sound (Hz)
λ : wavelength of sound wave (m)

Transmission of Sound

1. Unlike **em** waves, sound waves need a medium to be transmitted. (eg air, water)

2. Sound waves cannot be transmitted in vacuum. (Read up the Bell Jar experiment)

3. Speed of sound varies with different media.

Medium	Approximate speed (m/s)
Air	
Water	
Glass	

4. Temperature and humidity also are an important factor in the speed of sound.

Note:
The speed of sound is greatest in solids.
Sound cannot pass through a vacuum - it needs a medium.

Audible Sounds

- Audible means 'can be heard'
- For humans the audible range of sound is:

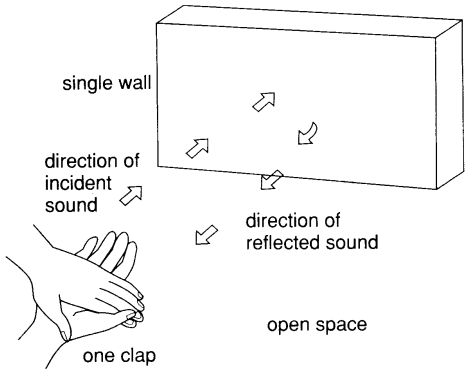
from _____ Hz to _____ Hz (_____ kHz)

- Many animals can hear noises much higher than this.
- As you get older the range decreases.

Reflection of Sound

Light waves undergo reflection. Like light, sound too undergoes reflection.

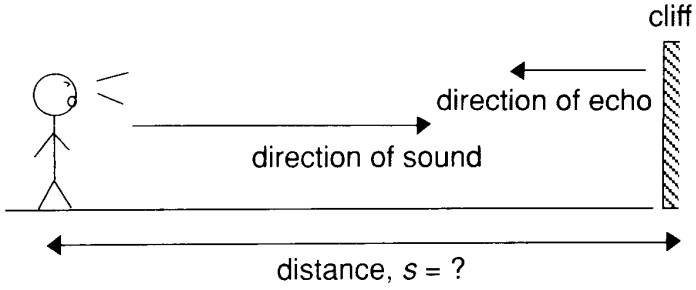
Proof:



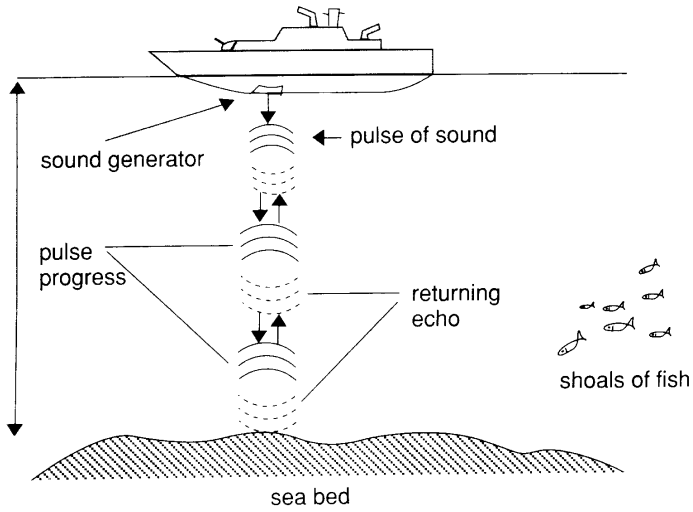
Effect of prolonged sound due to merging of many echoes is called *reverberation.*

Examples Involving Echoes:

1. A man stands some distance away from a cliff. He gives a shout and hears his echo 4 seconds later. How far is he from the cliff?



2. A ship sending sound signals to the bottom of the sea receives the echo back 0.5 s later. If sound travels at 1500 m/s in sea water, how deep is the sea?

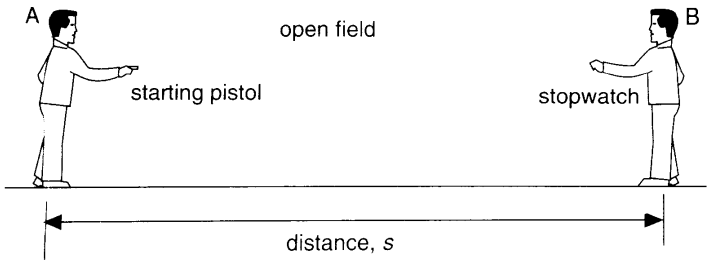


Measuring the Speed of Sound

This can be done easily by recording the time taken by sound in travelling over a known distance.

Example:

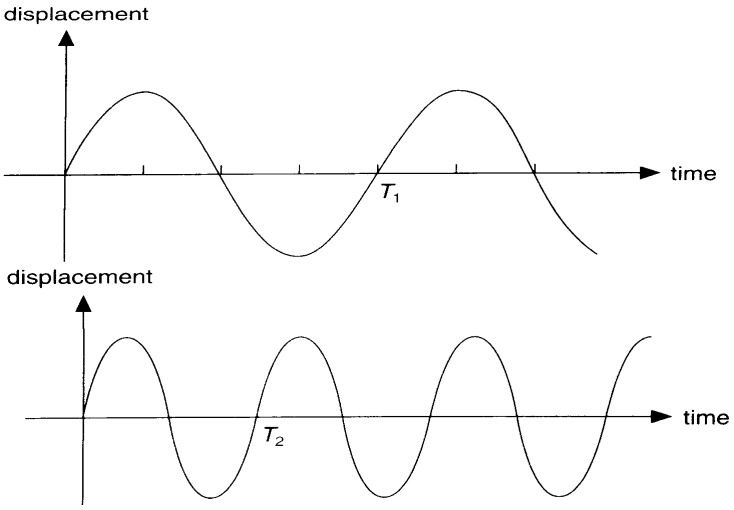
Assuming the measured distance is 800 m and the time taken for the sound to be heard by the second man is 2.4 s. What is the speed of sound?



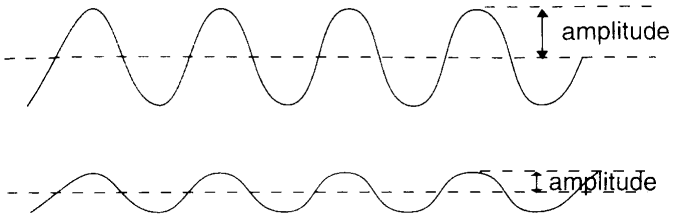
Pitch, Loudness and Quality

Pitch:

Pitch is related to the frequency of the sound wave:



Loudness:



Quality: