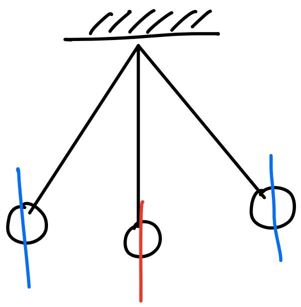
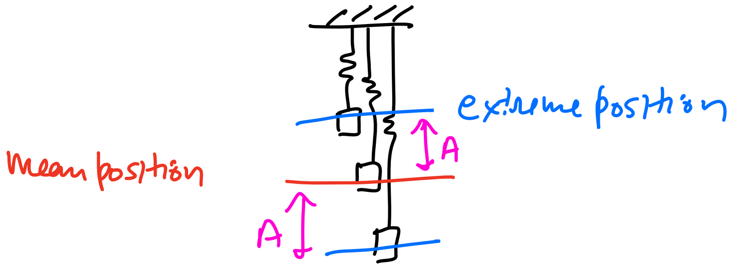
Vibration / ossilation





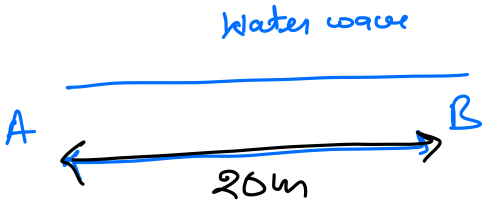
Period (T)

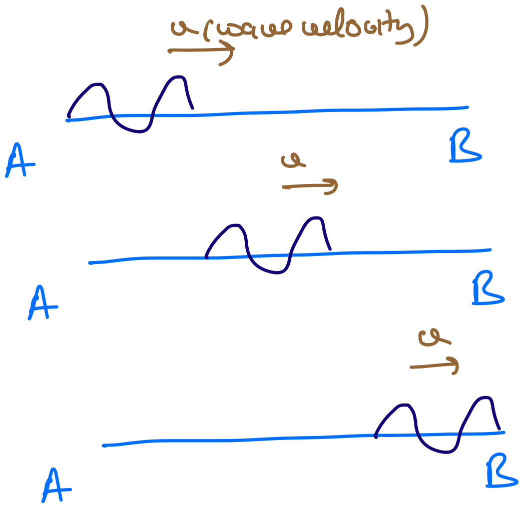
frequency (f) → Number of cycles/ossilations complete in one second

S.I unit - Hz

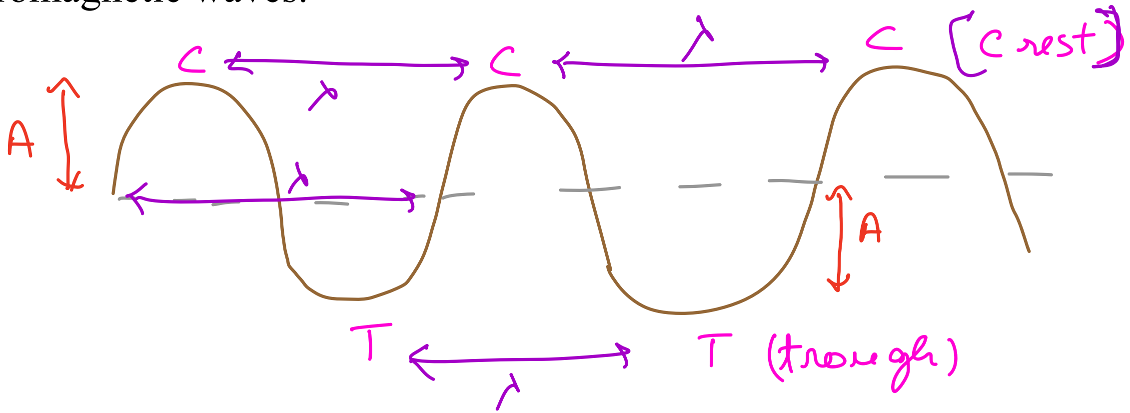
Amplitude (A) → Distance between mean position and any one extreme position

Wave → Transfer of energy from one place to other with some speed called wave speed



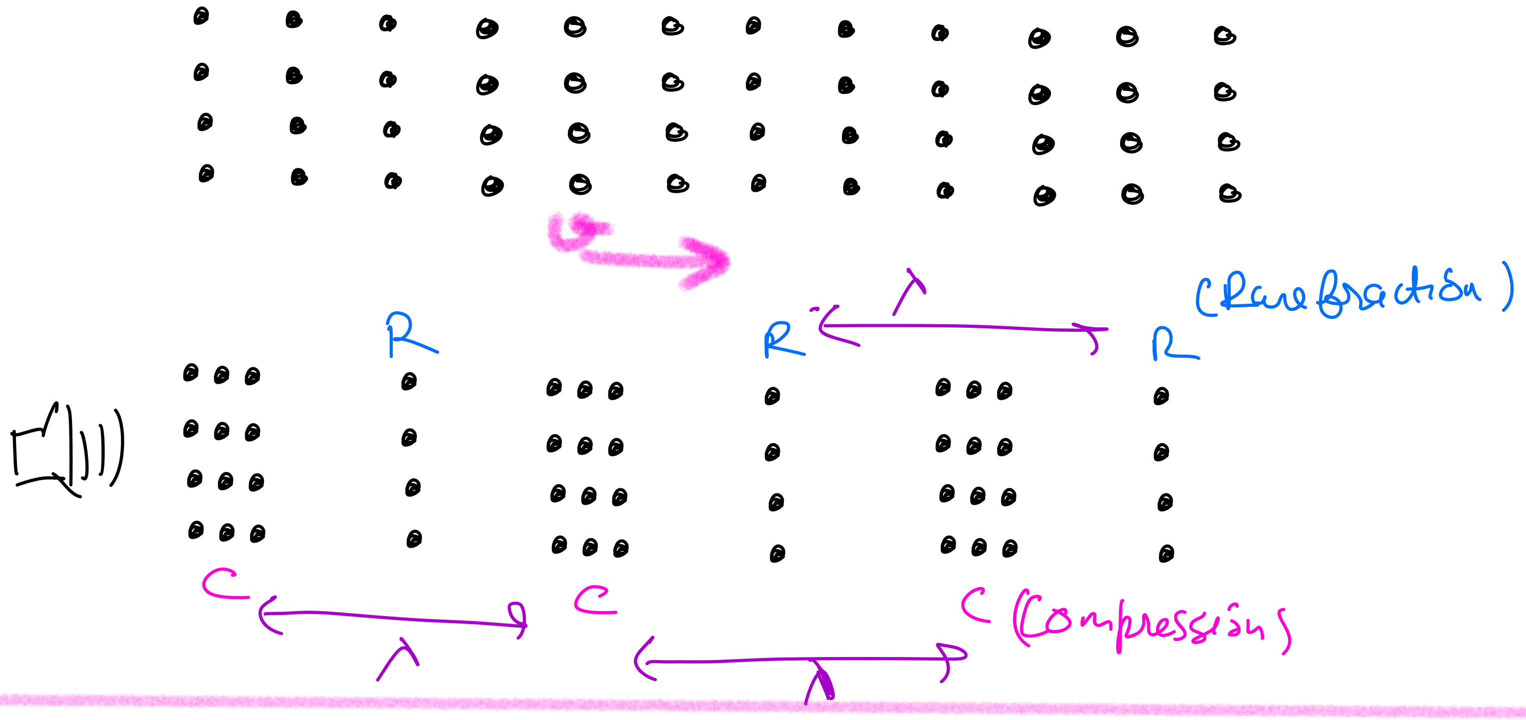


Transverse wave is a wave in which the particles of the medium oscillate perpendicular to the direction of wave velocity. Examples are water wave, wave on string, and electromagnetic waves.



Wavelength (λ) → Distance between two consecutive/Successive crests or troughs

Longitudinal wave → The particles of the medium oscillate parallel to wave velocity ex Sound



(Wavefronts)

Wave equation

$$v = \lambda f$$

frequency

wavelength

speed of wave

(depends upon medium)

	air	liq	solid
Sound	320~340 m/s	1200 ~ 1800 m/s	3500 m/s ~ 5000 m/s
	AIR		(glass)
Light	3×10^8 m/s (approx)		2×10^8 m/s (approx)

Light travels at a speed of 2.0×10^8 m/s in a glass block.

In the glass, the wavelength of the light is 4.0×10^{-7} m.

What is the frequency of the light?

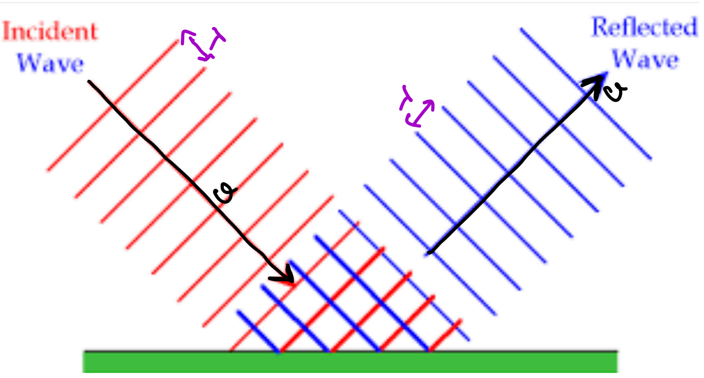
A 2.0×10^{-15} Hz

B 1.3×10^{-2} Hz

C 80 Hz

D 5.0×10^{14} Hz

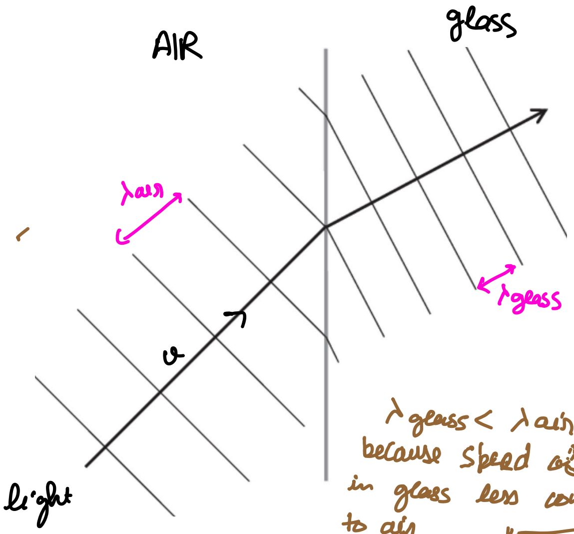
Reflection



Speed – Same
wavelength – Same
frequency – Same

Refraction

Bending of wave when it goes from one medium to other



$\lambda_{glass} < \lambda_{air}$ because speed of light in glass less compared to air

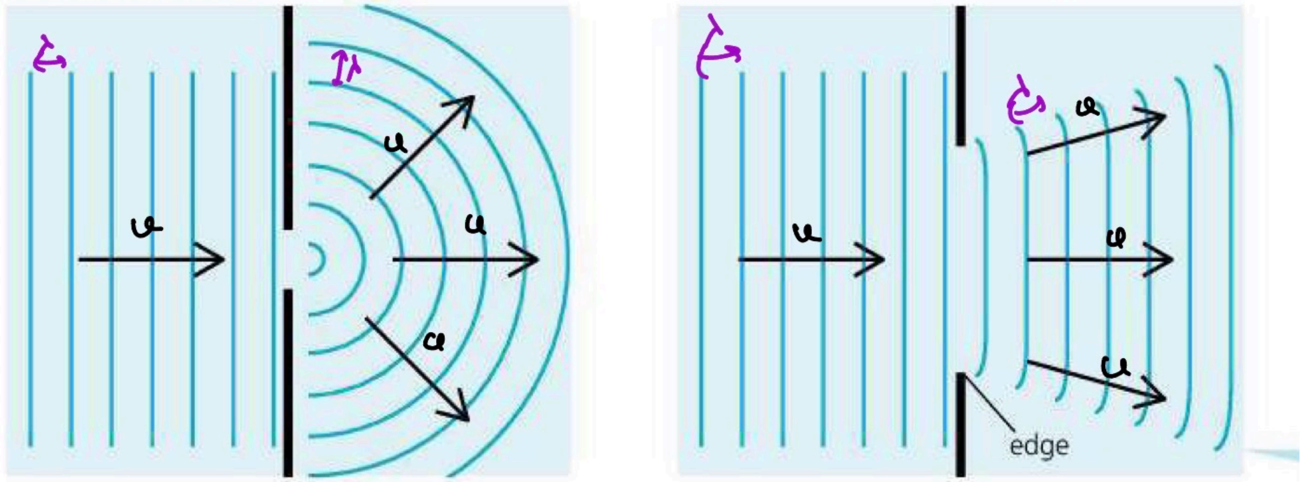
$\boxed{v = \lambda f}$

frequency – Same
wavelength – change
speed – change

Diffraction

more diffraction

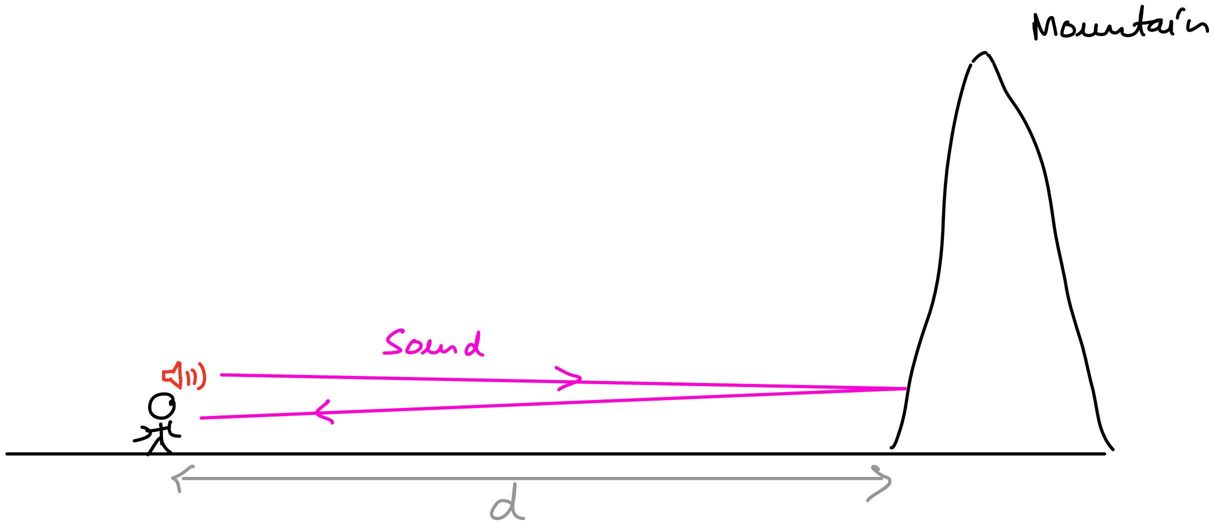
less diffraction



The waves bend round the sides of an obstacle, or spread out as they pass through a gap. The effect is called **diffraction**.

Diffraction is only significant if the size of the gap is about the same as the wavelength. Wider gaps produce less diffraction.

Echo



He hear echo of his sound after time "t"

Speed of sound is "v"

$$vt = 2d \Rightarrow \boxed{d = \frac{vt}{2}}$$

Pitch → frequency

loudness → Amplitude

Infra Sound	Audible Range of Sound	Ultrasound
$f < 20\,Hz$	↓	$f > 20000\,Hz$
(Highest wavelength)	Human ear can detect	(lowest wave-length)
	20Hz – 20000Hz	

$$\boxed{v} = \lambda f$$

↓

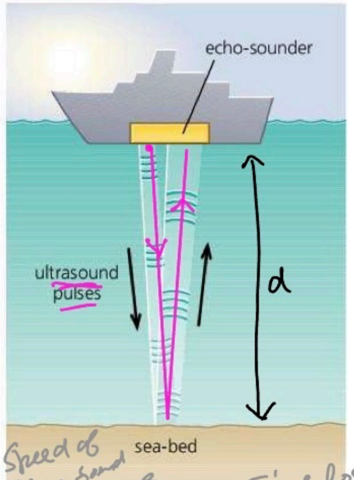
Same for Infra sound, Audible sound & Ultra sound

Electromagnetic Waves

Radiowave | Microwave | I.R (Heat wave) | (Visible) Light R . . . . . V | U.V | X ray | gamma rays

f ↑

λ ↓



Speed of ultra sound in water

$d = \frac{vt}{2}$

Time for pulse to come back after reflection

Echo-sounding*

Ships use **echo-sounders** to measure the depth of water beneath them. An echo-sounder sends pulses of ultrasound downwards towards the sea-bed, then measures the time taken for each echo (reflected sound) to return. The longer the time, the deeper the water. For example:

If a pulse of ultrasound takes 0.1 second to travel to the sea-bed and return, and the speed of sound in water is 1400 m/s:

distance travelled = speed × time = 1400 m/s × 0.1 s = 140 m

But the ultrasound has to travel down *and back*:

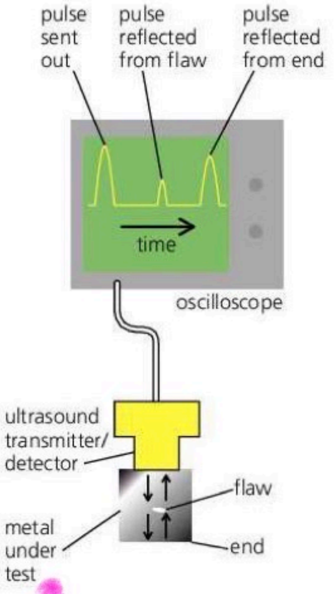
So: depth of water = ½ × 140 m = 70 m

Most echo-sounders **scan** the area beneath them – they sweep their ultrasound beam backwards and forwards and from side to side. A computer displays the depth information as a picture on a screen.

▶ This bat uses ultrasound to locate insects and other objects in front of it. It sends out a series of ultrasound pulses and uses its specially shaped ears to pick up the reflections. The process is called **echo-location**. It works like echo-sounding.

Metal testing*

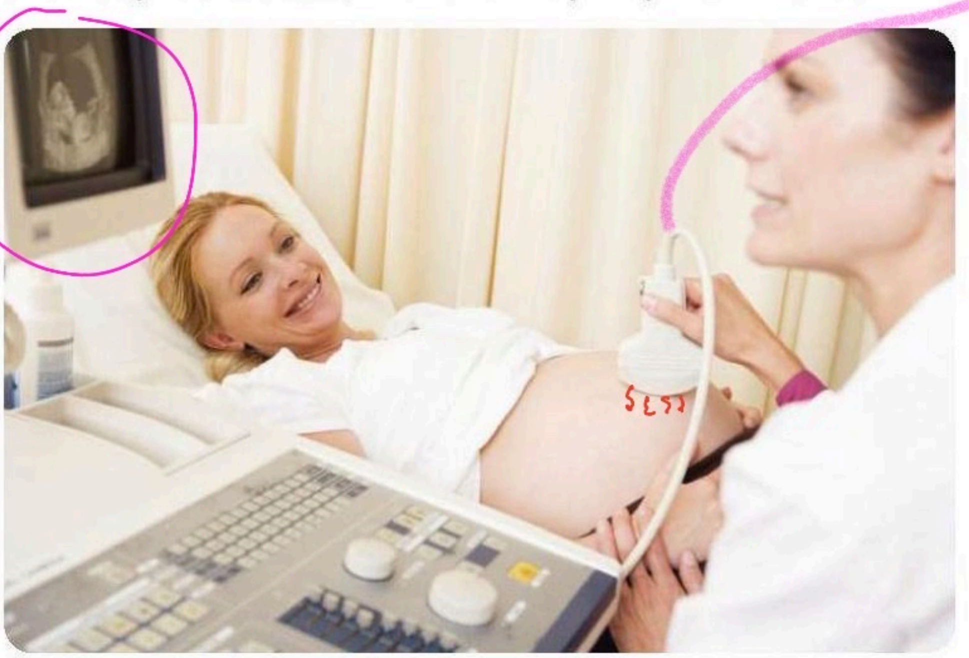
The echo-sounding principle can be used to detect flaws in metals. A pulse of ultrasound is sent through the metal as on the right. If there is a flaw (tiny gap) in the metal, *two* reflected pulses are picked up by the detector. The pulse reflected from the flaw returns first, followed by the pulse reflected from the far end of the metal. The pulses can be displayed using an oscilloscope. The trace on the screen is a graph showing how the amplitude ('strength') of the ultrasound varies with time.



Scanning the womb*

The pregnant mother in the photograph below is having her womb scanned by ultrasound. Again, the echo-sounding principle is being used. A transmitter sends pulses of ultrasound into the mother's body. The transmitter also acts as a detector and picks up pulses reflected from the baby and different layers inside the body. The signals are processed by a computer, which puts an image on the screen.

Using ultrasound is much safer than using X-rays because X-rays can cause cell damage inside a growing baby. Also, ultrasound can distinguish between different layers of soft tissue, which an ordinary X-ray machine cannot.



◀ An ultrasound scan of the womb. The nurse is moving an ultrasound transmitter/detector over the mother's body. A computer uses the reflected pulses to produce an image.

(a) One difference between a longitudinal wave and a transverse wave is that a longitudinal wave consists of compressions and rarefactions.

(i) Explain the terms compression and rarefaction using ideas about particles.

compression ....

....

....

rarefaction ....

....

....

(ii) Describe **one** other way in which longitudinal wave motion differs from transverse wave motion.

Longitudinal wave motion ....

....

....

Transverse wave motion ....

....

....

(b) **(i)** A sound wave of frequency 0.120 kHz travels through a rock at a speed of 3500 m / s.

Calculate the wavelength of the wave.

wavelength = ...

(ii) The wave travels from the rock into the air.

State and explain whether the wave will be audible to a healthy human ear.

statement ....

explanation ....

....

Sound from a loudspeaker is travelling in air towards a solid wall.

Fig. 7.1 shows compressions of the incident sound wave and the direction of travel of the wave.

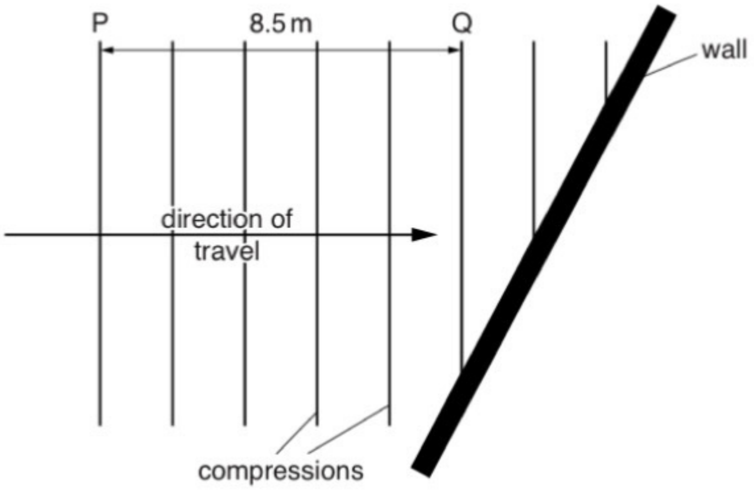


Fig. 7.1

(a) State what is meant by a *compression*.

....

....

(b) The distance from point P to point Q is 8.5 m. It takes 25 ms for the compression at P to reach Q.

For this sound wave, determine

(i) the wavelength,

(ii) the frequency.

(c) As it strikes the wall, the sound reflects.

Complete Fig. 7.1 to show the positions of three compressions of the reflected sound wave.

(d) The loudspeaker is immersed in water, where it continues to produce sound of the same frequency.

State and explain how the wavelength of the sound wave in water compares with the wavelength determined in **(b)(i)**.

....