Wave motion

L> wave : is an oscillation accompanied by a transfer of energy.

L> Frequency : refers to the addition of time

L> Wave motion : tranfers energy from one point to another.

which displace particles of the transmission medium that is, with little or no associated mass transport

L> wave consist, instead, of oscillations or vibration around almost fixed locations.

Mechanical waves

L> A mechanical waves : is a wave that is an oscillation of matter, therefore tranfere energy through a medium.

L> While wave can move over long distance, the movement of the medium transmission (material) is limited

L> oscillation material does not move far from its initial position.

L> Mechanical wave : transport energy which propagation in the same direction as the wave

L> Mechanical wave can be produced only in media which possess elasticity and inertia

A mechanical wave

L> require an initial energy input

L> once this energy is added the wave travels through the medium until all its energy is transferred.

L> in contrast, electromagnetic wave require no medium, but still can travel through one

An important property of Mechanical wave :

-> their amplitude are measured in an unusual way :

displacement of the medium / its wavelength

L> When this gets comparable to unity, significant effects such as harmonic generation may occur

L> and if large enough, may result in chaotic effects.

For example

wave on the surface of body of water break when this dimensionless amplitude exceed 1.

resulting :

-> foam on the surface

-> turbulent mixing

L> some of the most example of Mechanical wave : water wave, sound wave, seismic wave.

L> there are three type of Mechanical wave :

-> transverse waves

-> longitudinal wave

-> surface wave.

Transverse waves

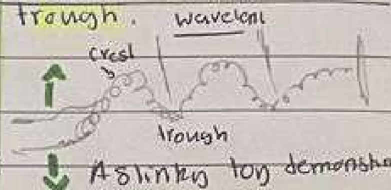
L> cause the medium to vibrate at right angle to the direction of the wave.

L> have two parts : crest and the trough

L> the crest : is the highest point of the wave

L> the trough : is the lowest point of the wave

L> its wavelength : is the distance from crest to crest or from trough to trough.



A slinky toy demonstrate the pattern of transverse wave

-> light also has properties of a transverse wave, although it is an electromagnetic wave.

Longitudinal waves :-

L> causes medium to vibrate parallel to the direction of the wave

L> consist of multiple compressions and rarefaction

L> The rarefraction : is the farthest distance apart in the longitudinal wave

L> the compression : is the closet distance together.

L> the speed of longitudinal wave is increased due to the close proximity of the atom in the medium that is being compressed

L> sound is considered a longitudinal wave

Surface waves :-

L> this type of wave travel along a surface that is between two medium

L> An example of surface wave :

-> wave in a pool,

-> the ocean any other body of water

there are two type of surface wave:
Rayleigh waves
Love waves
L> Rayleigh waves: also known as ground roll, are waves that travel as ripples similar to waves on the surface of water.
L> Love waves: is a surface wave having horizontal waves that shear or transverse to the direction of movement
L> this usually travel faster than Rayleigh and have the largest amplitude

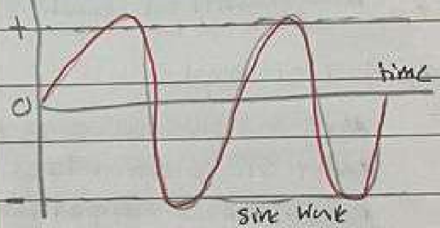
Electromagnetic waves

L> The second main type of wave is electromagnetic wave, do not require medium.
L> they consist of:
-> periodic oscillation of electrical
-> magnetic field which are generated by charged particles.
-> can travel through a vacuum
L> these wave include: radio wave, microwave, infrared, visible light, ultraviolet radiation, X-rays and gamma rays.
L> electromagnetic wave can be
-> transverse: where disturbance create oscillation that are perpendicular to the propagation of transfer energy.
-> longitudinal: where oscillation are parallel to the direction of energy propagation
-> Mechanical wave: can be both longitudinal and transverse.

L> All electromagnetic waves are transverse in free space.

Sinusoidal wave motion

L> sine or sinusoidal wave: is a mathematical curve that describe a smooth repetitive oscillation
L> is a continuous wave.
L> is an important in physics because it retains its wave shape when added to another sine wave of the same frequency
L> it is only periodic waveform that has this property.
L> the human ear can recognize single sine wave as sounding clear because, sine wave are representation of a single frequency without harmonics.



sine wave is a steady wave with repeating amplitude and frequency

Interference phenomenon

L> wave interference: is the effect of combining two or more waves moving on intersecting path.
L> the effect is: of combining the amplitude of each individual wave
L> if both waves are of the same frequency and phase (they move at the same rate) the amplitude are reinforced, producing constructive interference.
L> if two waves are out of phase, the result is destructive, producing complete annulment
L> for example, if two stones are dropped in the pool of water, NO: waves spread out from each source -> interference occurs where they combine
L> interference constructive result where the crest of one coincides with the crest of the other.
L> interference also occurs between two waves moving in the same direction but having different λ and f.
L> the effect is complex wave.
L> The pulsating frequency also called a beat result when the λ are slightly different
L> Interference between waves traveling in opposite direction produce standing waves

Standing Waves:-

L> or stationary wave is a wave in which its peaks do not move spatially
L> The amplitude of the wave at a point in space may vary
L> but its phase remains constant
L> the location at which amplitude is smallest are called nodes
L> the location where the amplitude is greatest are called antinodes
L> Standing waves were first noticed on the surface of a liquid in a vibrating container.

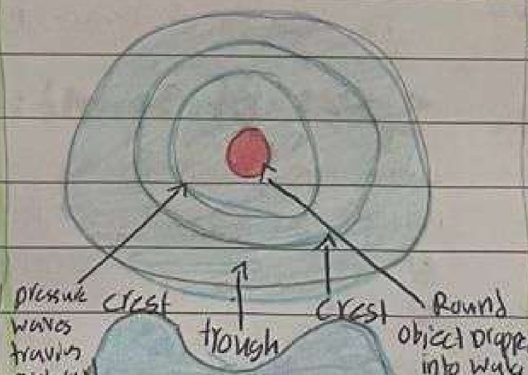
↳ it occurs because:
medium is moving in the opposite direction to the wave or
results:
interference between waves travelling in the opposite direction
↳ the most common cause of standing waves is resonance
↳ in which standing waves occure due to:
-> interference between wave reflected back and
-> forth at the same frequency
↳ for waves of = amplitude travelling in opposite direction, there is no net propagation of energy.

Sounds :-

↳ has been defined as:
a series of disturbance in matter that the human ear can detect.
↳ this definition can also be applied to
disturbance which are beyond the range of human hearing.
↳ there are three elements which are necessary for the transmission and reception of sound.
-> source
-> medium for carrying the sound
-> detector.
↳ anything that moves back and forth (vibrates) and disturbs the medium around it may be considered a sound wave
↳ An example of production and transmission of sound is ring of a bell
↳ when the bell is struck and begain to vibrate,
the particals of the medium (the surrounding air) in contact with the bell also vibrate.
↳ vibrational disturbance is
transmitted from one partical of the medium to the next,
vibration travel in a "wave" through the medium until they reach the ear.
↳ the eardrum,
acting as detectors, is set in motion by the vibrating particals of the air.
brain interprets this vibration as the sound of the bell

Sound waves :-

↳ is a mechanical wave
since sound is a wave motion in matter.
↳ it can best be undersooted by first considering water wave
↳ when an object thrown in a pool,
a series of circular waves travel away from a disturbances



Relationship between sound and water waves

in figure 5-4. such waves are seen from top perspective. with a wave travelling out of a center.
↳ in cross-section perspective in figure 5-4.
water waves are successive of crests and troughs
↳ the wavelength is the distance from the crest of one wave to the crest of the next.
↳ water waves:
are known as transverse wave. because the motion of water molecules is up and down, or
at right angle to the direction in which the waves are travelling.
↳ this can be seen by observing a cork on the water, bobbing up and down as the wave pass by.
↳ sounds travels through matter
in the form of longitudinal wave motion
↳ these waves are called longitudinal wave because
partical of the medium vibrate back and forth longitudinal in the direction of propagation.

When tine of a turning fork moves in outward direction,
1. the air immediately in front of the tine is compressed
2. so, momentary pressure is raised above
3. that at other point in the surrounding medium.
Because air is elastic, this disturbance is transmitted progressively in the outward direction from the tine in the form of compression waves.

When tire return and moves in an inward direction,

-> the air in front is rarefied
-> its momentary pressure is reduced below that at other point in surrounding medium
-> this disturbance transmitted in the form of rarefaction (expansion) wave, &
-> and follows compression wave through medium

The progress of any wave involve two distinct motion:

-> the wave itself moves forward with constant speed
-> simultaneously, the particles of the medium that convey the wave vibrate harmonically.

Examples of harmonic wave are

-> the motion of a clock pendulum.
-> balance wheel in a watch
-> piston in reciprocating engine

L> As longitudinal sound waves progress out from its source,

Another pattern can be discerned 90° to the longitudinal wave

this transverse amplitude wave is sinusoidal as the vibration varies between Max and mini amplitude.

When two or more waves overlap or combine

they demonstrate interference phenomena.

-> if the waves arrive at the listener in phase they will enhance and the sound disturbance is larger
-> if the waves arrive out of phase they will partially cancel each other out.

L> the distinctive interference pattern of large and then small repeating disturbance is heard.

L> Sound canceling headphones take advantage of this interference phenomena type of

L> As sound reaches the headset an out of phase interference wave is created

L> it is broadcast in the set so that

-> original sound wave
-> and broadcast waves interfere
-> the sound disturbance is reduced to nearly nothing

Speed of Sound:

L> in any uniform medium, under given physical condition, sound travels at a definite speed.

L> in some substance, velocity of sound is higher than in others.

L> Even in the same medium under different condition of temperature, the pressure, and so forth,

the velocity of speed varies.

L> What are two basic physical properties which govern velocity of sound ??

Density and elasticity.

L> a difference in density of two substance is sufficient to indicate which one will be the faster transmission medium for sound.

For example:-

sound travels faster through [water] than it does through [air] at same temperature

An outstanding example among these exceptions involves comparison of speed of sound in lead and Al at the same temperature.

-> sound travels at 16 700 fps in Al at 20°c
-> sound travels at 4030 fps in lead at 20°c.

despite the fact that lead is much more dense than Al.

the reason for such exception is found that that sound velocity depends on elasticity and density.

using density as a rough indication of speed of sound in a given substance,

it can be stated a general rule:

-> Sound travel fastest in solids material
-> slower in liquids
-> slowest in gases

The velocity of sound in air at 0°C (32°F) is 1087 fps and increases by 2 fps for each degree °C of temperature rise (1.1 fps for each °F)

speed of sound :
is the distance travelled per unit time by a sound wave as it propagates through an elastic medium.

speed of sound varies as altitude increases.

Mach number :-

In study of aircraft fly at supersonic speeds, it is custom to discuss speed in relation to the speed of sound

1223 kph (760 mph) at 15°C (59°F.)

Mach number is :
has been given ratio of the speed of an aircraft to the speed of sound

or

ratio of velocity of an aircraft over speed of sound

$$M = \frac{V}{a}$$

V → velocity of aircraft
M → mach number
a → speed of sound

production of sounds:

sound is produced when something vibrate.
vibrating body cause the medium (water, air, etc.) around it to vibrate.
vibrating in air are called travelling longitudinal wave, which we can hear.

Sound waves consist of area of high and low pressure called compression and rarefractions.

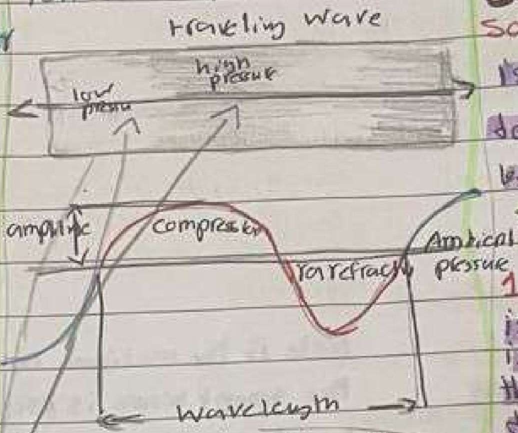


Figure 5-6. is a traveling wave.

shaded bar above represents the varying pressure of the wave
lighter area represent low pressure (Rarefraction)
dark area represent high pressure (compression)

one wavelength of wave is highlighted in red.
→ this pattern repeats indefinitely
→ the wavelength of voice is about one meter long
→ the wavelength and speed of the wave determine pitch, or frequency of the sound.

↳ since sound travels at 343 m/s at standard temperature and pressure speed is a constant.

↳ $Frequency = \frac{speed}{wavelength}$

the longer the λ, the lower the pitch.

↳ Amplitude is the hight of the wave.

↳ determind :
how loud a sound will be

Greater [illegible] means the sound will be louder

sound intensity :

Sound intensity :
is measured in decibels, with a decibel being the ratio of one sound to another.

1 decibels (dB) :
is the smallest change in sound intensity the human ear can detect.

→ faint whisper would have intensity 20 dB
→ pneumatic drill would be 80 dB.
→ the engine on a modern jetliner, at takeoff thrust, would have sound intensity 90 dB, when heard by somone standing 1so ft away.
→ 110 dB. noise, by comparison, would sound twice as loud as the jetliner engine

pitch and quality

The term "pitch" is used to describe frequency of sound

↳ the outstanding recognizable different between tones produced by two different keys on a piano is a difference in pitch.

↳ the pitch of tones is proportional to the number of compression and rarefraction received per second/

↳ which in turn,

is determined by the vibration frequency of sounding source.

A good example of frequency is noise generated by a turbofan engine on a commercial airliner.

↳ the high tip speeds of fan in front of the engine creates high frequency sound

↳ the hot exhaust creates low frequency sound.

Loudness :-

→ when a bell rings, the sound waves spread out in all direction and sound heard in all direction.

→ when bell struck lightly the vibration are of small amplitude and sound is weak.

→ when bell blow stronger, the vibration are of great amplitude and sound is louder.

↳ it's evident that, the amplitude of the air vibration is greater when the amplitude of vibration of source is increase

↳ loudness of the sound depend on the amplitude of the vibration of the sound waves

As distance from the source increase,

→ the energy of each wave spread out

→ sounds becomes weaker

As sound Waves Advances

variation in pressure occur at all point in the transmitting medium.

The greater pressure variations, the more intense the sound wave.

↳ intensity is proportional to the square of the pressure variation regardless of the frequency.

thus, by measuring pressure changes, the intensities of sound having different frequency can be compared directly.

Note if the medium in which the sound wave is propagating has boundries,

the wave will reverse when it hits boundary and travel back in the direction from which it came.

↳ the original and reflected wave can combine to form standing wave

↳ dependent on

→ distance of the boundary

→ frequency

→ wavelength of the sound

Doppler Effect

When sound is coming from moving object, the object forward motion adds to the frequency as sensed from the front and takes away from frequency as sensed from the rear.

this change in frequency known as Doppler effects

↳ it explains why the sound from an aircraft seems different as it approaches compared to how it sounds as it flies overhead,

As it approaches, it becomes both louder and higher pitch

As it flies away, the loudness and pitch both decrease notically

If an aircraft is flying at or higher than speed of sound,

sound energy cannot travel out ahead of aircraft

Because:

the airplanes catches up to it the instant it tries to leave.

↳ sound energy being created by

& → the airplane piles up

→ attaches itself to the structure of the airplane.

↳ when an airplane approaches,

a person standing on the ground will not be able to hear it until it gets past their position.

Because

sound energy is actually trailing behind the airplane

↳ when sound of airplane is heared,

it will be in the form of what is called sonic boom.

NO. DATE:

Question :

What are three elements required for the transmission and reception of sound :-

-> source
-> medium for carrying the sound
-> detector

The ratio of the speed of an aircraft to the speed of sound is called ?

mach number

the amplitude of a sound wave determine the loudness of the tone that is heard

what type of wave is associated with production of music

longitudinal wave

if two ~~same~~ mechanical waves of equal amplitude and frequency meet, what will occur?

⇉ the waves will cancel eachother

name five type of wave which can travel without the need of medium.

-> radio waves
-> microwaves
-> light waves
-> X- rays
-> gamma rays.

Nouf Albedwawi