Sound

TOPICS IN THIS CHAPTER

Introduction - Sound

Sound is a type of energy. Sound travels in the form of wave from one place to another.

Production of sound:-

Sound is produced because of the vibration of any object. In other words, when an object is vibrated it produces sound.

Example:-

- Sound can be produced by clapping of palms.
- Sound can be produced by vibrating a string.
- Sound can be produced by beating a table or diaphragm of a drum.
- Sound is produced by a flute because of vibration of air column.
- Sound is produced by a guitar because of vibration of its string.

Thus, an object is needed which could be vibrated to produce sound.

Propagation of sound:

When a stone is dropped in pond water, it produces many circular wrinkles and water appears to be travelling outwards from centre. These circular wrinkles are called ripples. This happens because of formation of waves in water.

When a stone is dropped in water, it creates a disturbance in water particles. The water particles pass the disturbance to the adjacent particles and the adjacent particles pass the disturbance to the next adjacent particles and so on. This phenomenon continues and the disturbance moves outward from the centre of disturbance. This makes water appear to be moving. In fact, water molecules do not travel in this case, rather only the disturbance is passed through particles of water. This creates wave in the form of ripples in water.

Sound travels from one place to another in similar manner i.e. through wave formation. In this case, the particles of medium do not travel rather only the disturbance; caused by

sound energy; passes to the adjacent particles of the medium. So, the traveling of sound is called propagation of sound.

Thus, sound propagates from one place to another in the form of waves, i.e. because of the disturbance of particles of the medium.

Wave – Sound Wave

The disturbance or oscillation from one location to another location; accompanied by transfer of energy is called wave.

There are two types of wave, viz. Electromagnetic Wave and Mechanical Wave.

ELECTROMAGNETIC WAVE – Wave that requires no medium to propagate is called Electromagnetic wave. For example – light wave. Light can also travel through vacuum.

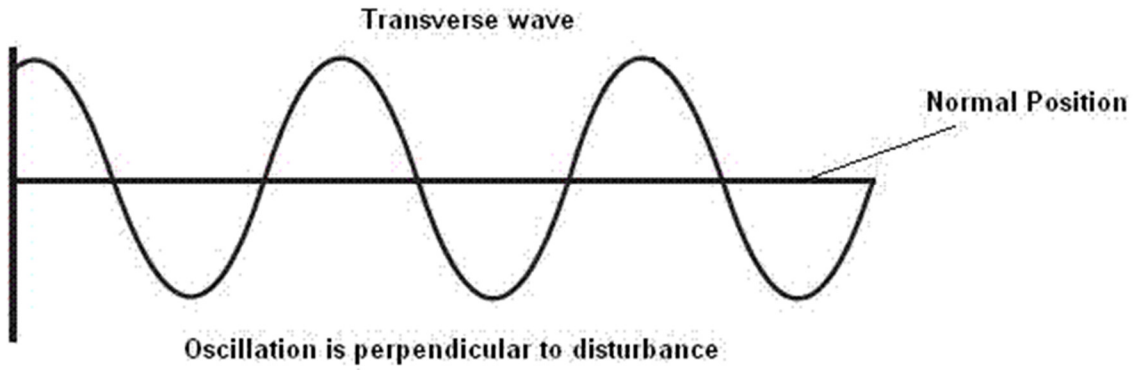
MECHANICAL WAVE – Wave that requires medium to propagate is called Mechanical Wave. For example - sound wave. Sound cannot travel in the absence of a medium.

TYPES OF WAVE - ON THE BASIS OF DIRECTION:

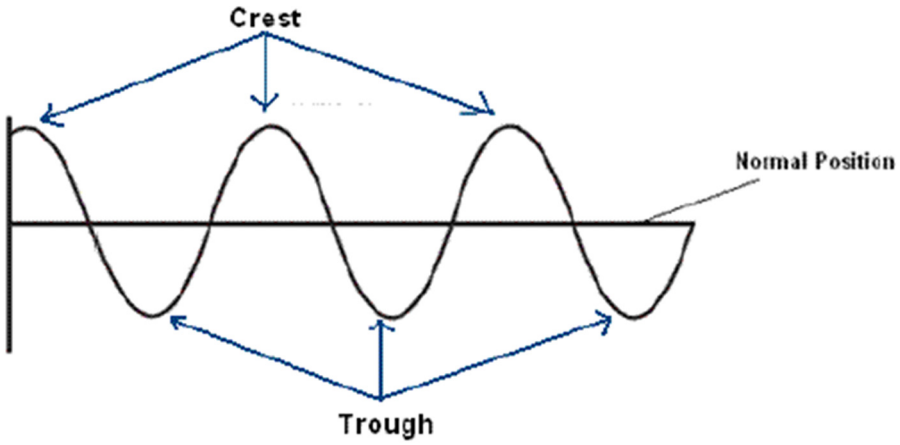
On the basis of direction of propagation, waves can be divided into two types –

1. Transverse Wave
2. Longitudinal Wave

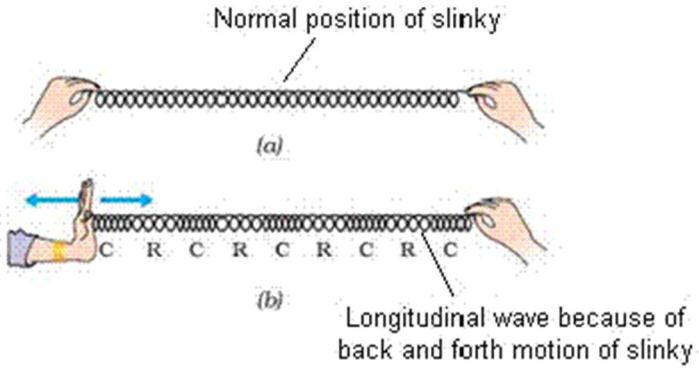
TRANSVERSE WAVE – The wave formed because of the oscillation perpendicular to the disturbance is called transverse wave. For example light wave, water wave, etc.



In transverse wave, particles oscillate in up and down directions; relative their normal position of rest. Particles of medium create elevation above the normal position or line of zero to the surface of medium and depression below the normal position in the course of oscillation. The elevation is called crest and the depression is called trough.



LONGITUDINAL WAVE – The wave formed because of the oscillation; parallel to the disturbance; is called longitudinal wave. For example; sound waves. ause of forward and backward movement of particles of the medium. If a slinky is pushed and pulled backward and forward, the wave formed in slinky is similar to longitudinal wave.



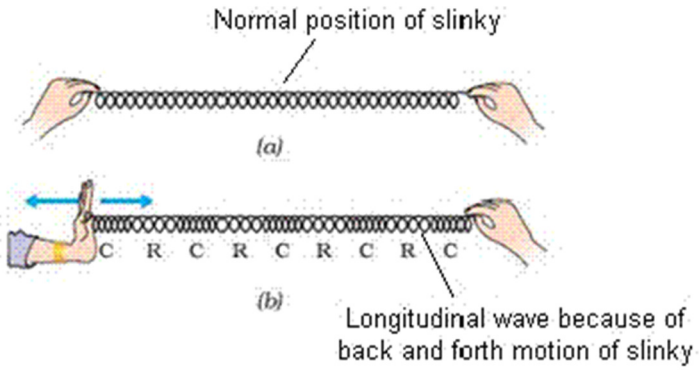
Ref: NCERT Book - Sound - class - IX

Sound Wave is longitudinal wave – Sound propagates because of oscillation of particles of medium parallel to the disturbance, thus sound wave is longitudinal wave.

Compression and Rarefaction:

When a slinky is jerked to and forth, two phenomena take place simultaneously. First, the coils come closer to each other while; on the other hand; some of the adjacent coils go farther from each other. This phenomenon continues and the wave goes forward.

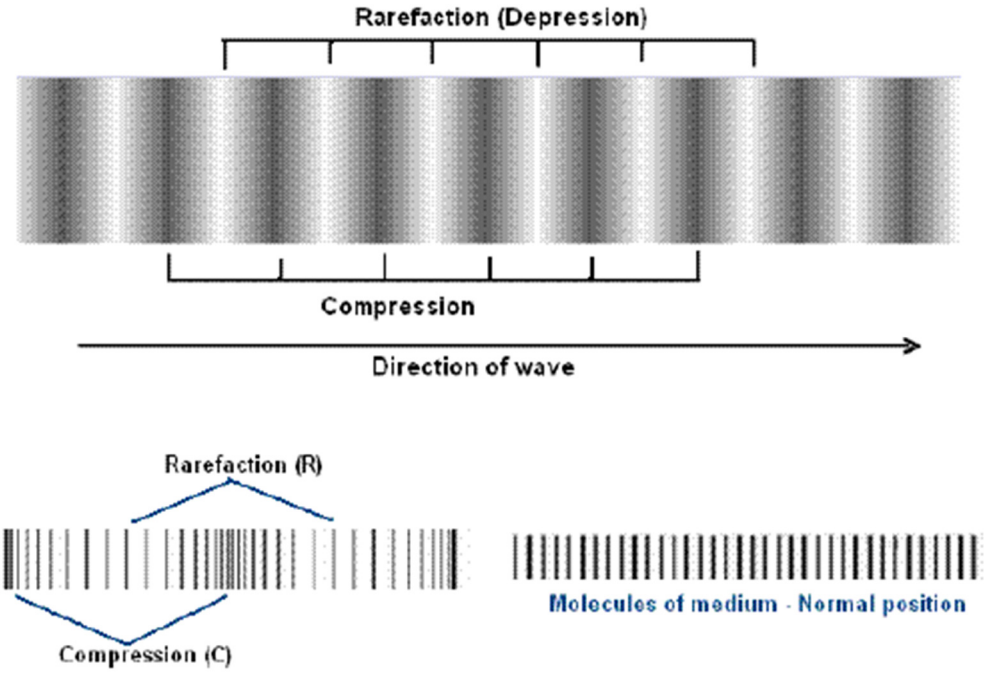
The action when coils come closer is called compression and when coils go farther from each other is called rarefaction.



Ref: NCERT Book - Sound - class - IX

In the given figure the area of compression is denoted by letter ‘C’ and the area of rarefaction is denoted by letter ‘R’.

When sound wave travels through a medium, say air, the particles of medium disturb in the same fashion, i.e. compression and rarefaction (depression). When air particles come closer it is called compression. On the other hand, when particles go farther than their normal position it is called rarefaction. This is similar to the compression and rarefaction produced in the slinky. In the condition of compression, molecules of medium come closer to each other and in the condition of rarefaction, molecules of medium go farther from each other; compared to their normal positions.



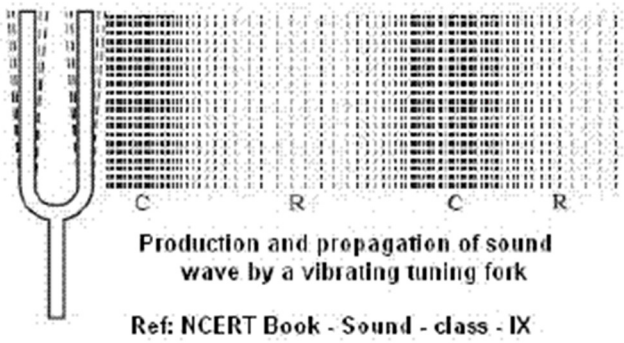
Density, pressure and disturbance:-

When compression takes place in the medium, the density and pressure of the medium increase. When rarefaction takes place in the medium, density and pressure of the medium decrease. This increase and decrease in density and pressure are temporary.

Thus, compression is called the region of high density and pressure. Rarefaction is called the region of low density and pressure.

Production of sound in laboratory:-

In laboratories, sound wave is produced by striking a tuning fork over a rubber pad. When prongs of the tuning fork are struck over a rubber pad, the prongs of tuning fork start vibrating and produce sound.



Production and propagation of sound wave by a vibrating tuning fork

Ref: NCERT Book - Sound - class - IX

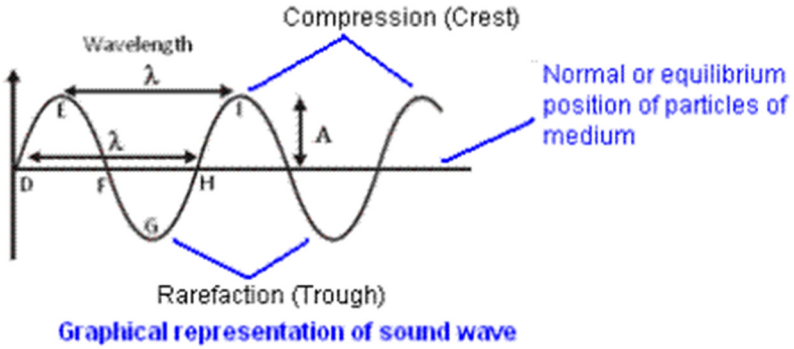
One can feel the vibration of prongs by touching them after striking over the rubber pad. The vibration produces sound energy. This sound energy creates disturbance in the medium by making compression and rarefaction and the sound wave propagates forward.

Characteristics of sound wave:

Following are the main characteristics of sound wave:

- Wavelength.
- Amplitude.
- Time period
- Frequency
- Velocity (Speed)

To discuss the characteristics of wave, a graphical representation of sound wave is considered.



Graphical representation of sound wave

The peak of a wave is called compression or crest. The valley of a wave is called rarefaction or trough.

WAVELENGTH:

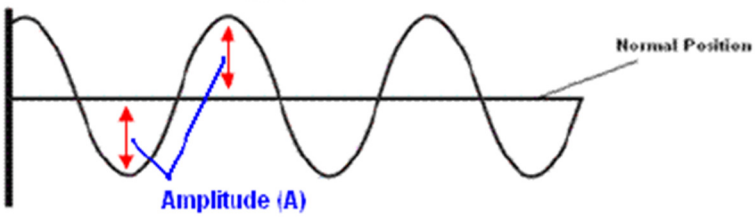
Wave length is the length between two consecutive peaks, i.e. crest or two consecutive valleys, i.e. trough of a wave. Wave length is represented by Greek letter λ (lambda).

Louder sound has shorter wavelength and softer sound has longer wavelength.

The SI unit of wavelength is metre (m).

AMPLITUDE:-

Magnitude of maximum disturbance on either side of the normal position or mean value in a medium is called amplitude. In other words, amplitude is the distance from normal to the crest or trough.



Amplitude is the energy of sound. Louder sound has greater amplitude and softer sound has shorter amplitude. Thus, louder or softer sound is determined by its amplitude. Since louder sound has greater energy consequently greater amplitude, thus it travels to a longer distance. Softer sound has smaller energy consequently shorter amplitude, thus it travels to a shorter distance.

Amplitude is denoted by letter ‘A’. The SI unit of amplitude is metre (m).

TIME PERIOD:

Time required to produce one complete wave is called time period or time taken to complete on oscillation is called the time period of the sound wave. In other words, time in which a wave moves a distance equal to its wavelength is called time period.

The time period of sound wave is represented by letter 'T'. The SI unit of time period is second (s).

FREQUENCY:

The number of sound waves produced in unit time is called the frequency of sound waves. For example, if a source of sound produces 20 sound waves in one second then the frequency is 20 Hz.

Time taken to calculate frequency is in second. Frequency is denoted by Greek letter 'v' (nu). The SI unit of frequency is 'hertz'.

This name had been given after the German Scientist Heinrich Rudolph Hertz.

Relation between time-period and frequency:

If 1 sound wave is produced by a source, in T second.

Therefore, in 1 second number of wave produced $= \frac{1}{T}$

Since, frequency is the rate of production of wave.

Therefore,

$$Frequency = \frac{1}{T}$$

$$\Rightarrow Frequency = \frac{1}{Time\ period} \Rightarrow \nu = \frac{1}{T}$$

Where, v = frequency and T = time period

Thus frequency is the reciprocal of the time period of wave. This means the frequency is increased with decrease in time and vice versa.

VELOCITY:

Distance covered by sound wave in unit time is called the velocity of sound wave.

Therefore, $Velocity = \frac{Distance}{Time\ taken}$

If distance = λ Time = T

Therefore, $Velocity = \frac{\lambda}{T}$

$or, \quad v = \frac{\lambda}{T} \text{ ----------(i)}$

SI unit of λ is metre (m) SI unit of time is second (s)

Therefore, SI unit of velocity = ms^{-1}

Therefore, velocity can be defined as distance travelled per second by sound wave.

Since, frequency $v = \frac{1}{T}$

Therefore, equation (i) can be written as

$v = \frac{\lambda}{T} = \frac{1}{T} \times \lambda = v.\lambda$

$or, v = v.\lambda \text{ ----------(ii)}$

$Where, v = velocity$

$\lambda = wavelenght$

$v\ (nu) = frequency$

Thus, velocity of sound wave = frequency X wavelength

This is called **WAVE EQUATION**. WAVE EQUATION is applied to all types of waves.

Thus, velocity of sound wave is the product of frequency and sound wave.

Quality of Sound

Timbre: The quality of sound is called timber of sound. Timber is one of the characteristics of sound that enables us to differentiate between two different types of sound.

Because of timbre; the sound of flute and harmonium or other musical instruments can be differentiated. For example; the frequency of a particular note 'Do' or 'Sa' produced by all the musical instruments is equal. In spite of that, because of different timbre one can differentiate the sound of same frequency of different musical instruments.

Different persons produce sound of different timbre. Because of different timbre in sound, the voice of different persons can be recognized.

Tone and Note of sound:-

Sound of a single frequency is called tone and sound of mixture of several frequencies is called note. A note is pleasant to listen.

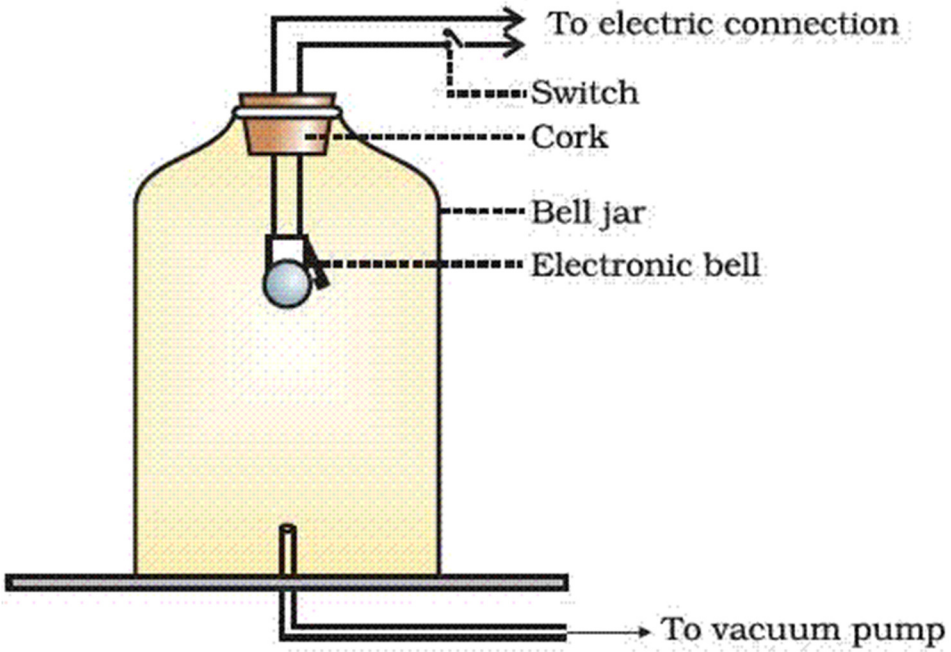
Noise is unpleasant to hear.

Music is pleasant to hear because of good quality, i.e. timbre while noise is unpleasant because of bad quality.

Medium is a must for propagation of sound wave:

Since sound wave travels by the compression and rarefaction of the particles, so a medium is necessary for propagation of sound wave. Sound cannot propagate without a medium.

Sound wave cannot propagSound wave cannot propagate through vacuum. This can be demonstrated using the bell jar apparatus.



Bell jar Experiment to show that medium is necessary for the propagation of sound

Ref: NCERT Book - Chapter - Sound

When all air is vacuumed out of bell jar, the sound of the bell is not heard outside. This happen because there is no medium present, consequently no particles present for compression and rarefaction in the bell jar through which sound waves could propagate.

Propagation (travelling) of sound through different media:-

Sound propagates through solid, liquid and gas. In all these media; sound wave propagates by the compression and rarefaction of particles of the medium.

Velocity of sound wave in different media:

The velocity of sound waves depends upon the following three factors:

- Nature of the medium
- Temperature
- Humidity present in air

Nature of medium:

The velocity of sound isThe velocity of sound is maximum in solid, moderate in liquid and minimum in gas. For example:

Medium	Velocity of sound
Iron	5130 m/s
Water	1500 m/s
Air	344 m/s

Temperature:

The velocity of sound is directly proportion to temperature. This means, velocity of sound increases with increase in temperature. For example: sound wave at 0^0C in air is 332m/s. The velocity of sound waves at 20^0C in air is 344m/s. This is the reason, we hear more clearly on a hot day than on a cold day.

Humidity present in air:

Since, velocity of sound wave in water is more than that in air, so humidity in air increases the velocity of sound. Therefore, an increase in humidity in air increases the velocity of sound and a decrease in humidity in air decreases the velocity of sound. This is the cause that we can hear more clearly in rainy season than in summer.

Reflection of Sound

Sound wave also gets reflected as light waves do. Bouncing back of sound wave from the surface of solid or liquid is called reflection of sound.

Reflection of sound follows the Laws of Reflection as light wave does. This means the angle of incident wave and reflected wave to the normal are equal.

For reflection of sound a polished or rough and big obstacle is necessary.

Use of Reflection of Sound:-

Reflection of sound is used in many devices. For example; megaphone, loudspeaker, bulb horn, stethoscope, hearing aid, sound board etc.

Loudspeaker, Megaphone, bulb horn:

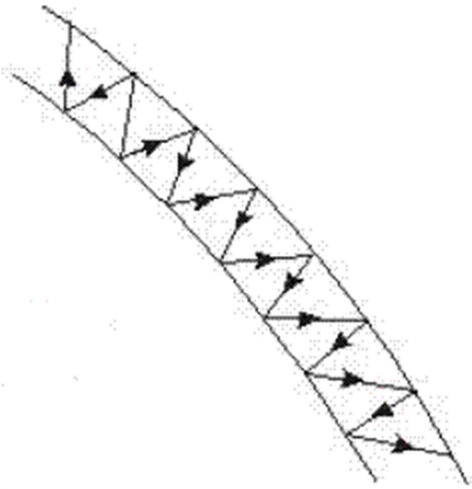
Loudspeaker, Megaphone and bulb horn are devices used to send the sound in desired direction without spreading the sound all around. These devices act on the laws of reflection of sound wave.

In such devices, a funnel like cone shaped tube is used. Sound is introduced at the narrower end of tube and let to come out from wider end. Because of successive reflections, the amplitude of sound is added up which makes the sound louder. The name 'Loudspeaker' is given as it is used to make the sound louder.

Stethoscope: –

Stethoscope is used to hear the sounds of internal organs of a patient; for diagnostic purposes. It works on the laws of reflection of sound.

Stethoscope



Muliple reflection of sound in the tube of stethoscope

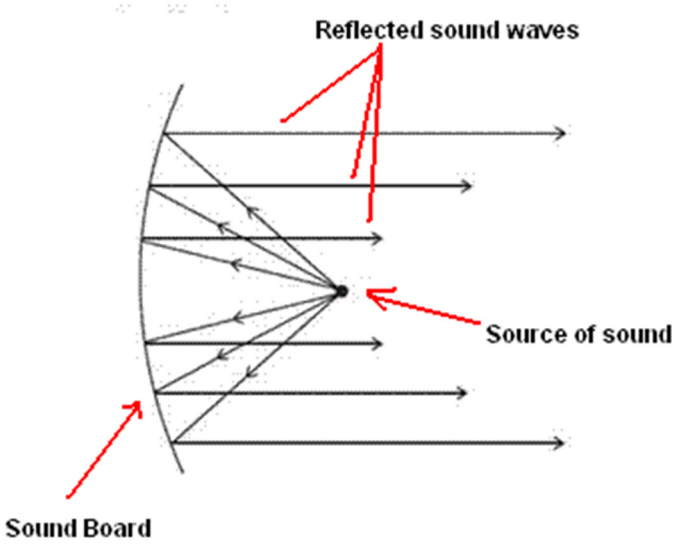
In stethoscope, sound is received by chest piece and sent to the earpieces by multiple reflecting through a long tube. Doctors diagnose the condition of an organ of the human body by hearing the sound using the stethoscope. Stethoscope has become the symbol of the medical profession since its invention.

Soundboard –

Sound board is used to send the sound towards audience in big hall or auditorium. This works on the basis of laws of reflection of sound waves.

Sound board is a big concave board and is set in such a fashion behind the stage that speaker is at the focus. Sound coming from speaker falls over sound board and gets reflected towards the audience. As a result, the audience sitting in the hall even at far distance from the speaker can clearly hear what the speaker is saying.

Additionally, the ceiling of the auditorium is also made curved so that it also acts like sound board. The curved surface of the ceiling reflects the sound waves and facilitates better hearing.



Echo:

The sound which we hear after reflection is called echo or echo of sound. One can hear the echo by shouting loudly in a big hall. After shouting loudly, the same sound reaches the ears after reflecting from the surface of the wall. Echo of sound can be heard by producing sound at place surrounded by hills or big buildings.

Thus, repetition of sound because of multiple reflection of sound wave is called echo.

Condition necessary for creation of echo:

One does not experience any echo sound in a small room. This does not mean that sound does not get reflected in a small room, but necessary conditions for production of echo are not present.

Any sound persists on one's brain upto 0.1 second of time. So echo can only be heard if the same sound comes to one's ear after a lapse of 0.1 second.

Thus, reflection of sound must reach to the brain after a lapse of 0.1 second.

Explanation:

Since, sound covers 344 m in air in 1 second.

Thus, in 0.1 second sound would cover a distance of 344 m x 0.1 = 34.4 m

Thus, to hear an echo sound the reflecting surface must be at a distance of 17.2 m, so that sound has to cover a distance which is more than 17.2 m x 2 = 34.4 m; before reaching the ears.

So, if reflecting surface is at a distance of more than 17.2 m, the sound would reach to our brain after 0.1 second and we would be able to hear the echo of sound.

Thus, there are two conditions to experience the echo of sound –

(a) Sound must come back to the person after 0.1 second.

(b) For above condition, the reflecting surface must be at a minimum distance of 17.2m.

Multiple Echo:

You may have heard the echo of your yahoo in hilly areas. This happens because of multiple reflection of sound wave and is often called multiple echoes.

The rolling sound of thunder is heard because of the multiple reflections of thunder sound or multiple echoes. The sound of thunder comes to us many times because of reflections from clouds and earth surface.

Use of multiple reflection of sound:

(a) In measuring the depth of sea/ocean.

(b) For the detection of the position of any objects, such as shipwrecks, sea rocks, hidden ice-berg in the sea and ocean.

(c) Investigating any problem inside the human body.

For above mentioned purposes, sound of high frequency is produced so that reflections can be received from various surfaces. The time taken for reception of reflected sound waves is analyzed by a computer to detect the problem.

Reverberations:

Persistence of sound wave for a long time because of multiple reflections is called reverberation. Usually, this happens in big halls. Sound becomes too blurred and distorted to be heard in big concert halls because of reverberation. This can often lead to annoyance.

To overcome this problem, sound absorbent materials, such as curtains, plant fibre, compressed fireboard, carpets, etc. are used in the auditorium.

These materials absorb undesired reflected sound and reduce reverberation.

Range of Hearing or Audible Range

The human ear can hear the sound between frequencies of 20 Hz to 20,000 Hz. Thus, audible range or range of hearing is between 20 Hz to 20,000 Hz; for human beings. However, children under 5 years of age can hear the sound upto 25000 Hz.

Sound beyond audible range of human being: Infrasound and Ultrasound

Infrasonic Sound or Infrasound

Sound, below the frequency of 20Hz is called infrasonic or infrasound. Infrasound is produced because of very slow vibration. For example; simple pendulum produces sound below 20Hz. Human being cannot hear infrasound as their ears are not adapted to hear the sound of such range.

Many animals; such as whale, elephant, rhinoceros, etc. can produce and hear sound having frequencies below 20 Hz.

Ultrasound or Ultrasonic Sound

Ultrasound or ultrasonic sound:- Sound, above the frequency of 20000 Hz is called ultrasound. Humans cannot hear the ultrasonic sound. However, many animals such as dogs, cat, bat, monkey, deer, etc. can hear ultrasound.

Bats catch their prey by producing ultrasound. Bat produces ultrasound and detects the reflected sound waves coming from any obstacle; such as a prey. By detecting the reflection of ultrasound, bat understands the position and type of prey or of any obstacle in the way. Some aquatic animals, such as dolphin, also use ultrasound to catch their prey.

USE OF ULTRASOUND

Ultrasound is sound waves of high frequency. Because of high frequency, ultrasound is associated with more energy and can penetrate upto a large extent. This characteristic of ultrasound makes it very useful for many purposes. Some of its uses are given here:

In detection of ailments in the human body.

In cleaning of machinery parts which are beyond reach without disassembling of parts.

Detection of any deformities in metal blocks.

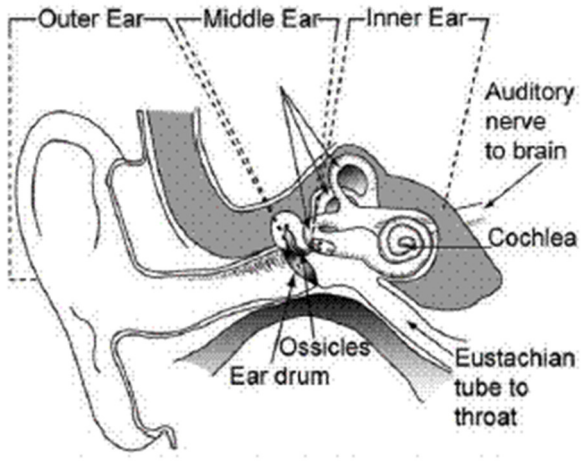
Detection of any blockade in pipe lines.

SONAR :-

SONAR: The full form of SONAR is SOund Navigation And Ranging. This is a device which is used to measure depth of sea bed, locate scraps, wrecks, submarines of enemies, etc. in the water by producing ultrasound. It is fitted over ships and submarines.

Ultrasonic sound waves are produced by SONAR and when these waves return after reflection from anything in water, they are analyzed with the help of computer. The shape and position of objects under sea and ocean is detected on the basis of speed and nature of reflected ultrasound waves.

Human Ear :



Structure of Human Ear:

The human ear can be divided into three main parts, viz. external ear, middle ear and internal ear.

External Ear: The external ear is outside the body and is also called pinna. It extends into the ear canal.

Middle Ear: The middle ear is composed of the ear drum or tympanum and the bone ossicles. There are three bone ossicles, viz. the hammer, the anvil and the strirrup.

Internal Ear: The internal ear is composed of a cochlea and three semi-circular canals. The cochlea makes the hearing apparatus and the auditory nerve from it goes to the brain.

Working of Human Ear: The external ear catches sound waves and channelizes them to the ear drum, via the ear canal. During compression, the pressure increases outside the ear drum which forces the eardrum to move inwards. During rarefaction, the pressure decreases outside the ear drum which forces the eardrum to move outwards. Thus, a vibration is produced in the eardrum. Further, the three bones amplify the sound wave, by vibrating in turns. In the inner ear, the vibrations are converted into electrical signals. These signals are transmitted by the auditory nerve to the brain. Finally, the brain interprets those signals as sound.

NCERT Book Class Nine In Text Questions and Answers

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Question: 1 - How does the sound produced by a vibrating object in a medium reach your ear?

Answer:- Vibrations in an object create disturbance in the medium and consequently compressions and rarefactions. Because of these compressions and rarefactions sound reaches to our ear.

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Question: 1 - Explain how sound is produced by your school bell.

Answer:- School bell starts vibrating when heated which creates compression and rarefaction in air and sound is produced.

Question: 2 - Why are sound waves called mechanical waves?

Answer: Since sound waves do some mechanical work while making disturbance in medium, hence sound waves are called mechanical wave.

Question: 3 -Suppose you and your friend are on the moon. Will you be able to hear any sound produced by your friend?

Answer: Since sound waves require medium to propagate and there is no medium present on the moon. So, I will not able to hear the sound of my friend on the moon.

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Question: 1 - Question: 1 - Which wave property determines (a) loudness, (b) pitch?

Answer: (a) Amplitude of sound waves determines loudness. Louder sound has greater amplitude and vice versa.

(b) Frequency of the sound waves determined pitch of the sound.

Question: 2 - Guess which sound has a higher pitch: guitar or car horn?

Answer: Sound of the car horn has higher pitch.

Question: 3 - What are wavelength, frequency, time period and amplitude of a sound wave?

Answer: Wavelength: Wavelength is the distance between two consecutive compressions or rarefaction of wave.

Frequency: The number of sound wave produced in one second is called frequency.

Time period: Time period is the time taken to produce one wave of sound.

Amplitude: Amplitude is the maximum displacement along the mean position of the particles of medium.

Question: 4 - How are the wavelength and frequency of a sound wave related to its speed?

Answer: The relation between frequency and wavelength of sound wave is given as follows:

Velocity (v)=Wavelength(λ)X Frequency (v), $v = \lambda X v$

This means the speed is equal to the product of wavelength and frequency of the sound wave.

This equation is also called the ‘wave equation’ and applicable to all types of wave.

Question: 5 - Calculate the wavelength of a sound wave whose frequency is 220 Hz and speed is 440 m/s in a given medium.

Answer:

Given,

Frequency (v) = 220 Hz

Velocity (v) = 440m/s

Wavelength (λ) =?

We know;

$$v = \lambda \times \nu$$
$$Or, 440 m/s = \lambda \times 220 Hz$$
$$Or, \lambda = \frac{440\ ms^{-1}}{220 Hz} = 2m$$

Thus, wavelenght = 2m

Question: 6 - A person is listening to a tone of 500 Hz sitting at a distance of 450 m from the source of the sound. What is the time interval between successive compressions from the source?

Answer: Since, the time interval between successive compressions is called time period or time interval.

Here given,

Frequency (v) = 500Hz

T (Time period) =?

We know that;

$$Frequency = \frac{1}{T}$$
$$Or, T = \frac{1}{Frequency}$$
$$Or\ T = \frac{1}{500\ Hz} = 0.002\ s$$

Thus, time interval between two consecutive compression of the given wave = 0.2 s

Question: 7 - Distinguish between loudness and intensity of sound.

Answer: Loudness of sound is determined of amplitude and intensity of the sound wave is determined by frequency of sound waves.

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Question: 1 - In which of the three media; air, water or iron does the sound travel the fastest at a particular temperature?

Answer: At particular temperature sound travels fastest in iron.

Page 168

Question: 1 - An echo returned in 3 s. What is the distance of the reflecting surface from the source, given that the speed of sound is 342 m /s?

Answer: To return an echo sound has to cover distance of two way.

Here, given,

Speed of sound = 342 m/s

Time = 3s

Thus,

Distance = speed X time

⇒ Distance = 342m/s×3 s=1026 m

Thus,the distance between the source and reflecting surface=1026÷2=513m

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Question: 1 -Why are the ceilings of concert halls curved?

Answer: Since, concert halls are big, so audience at the back rows of the hall may not hear clear sound of speaker. To overcome this problem, the ceiling of the concert halls is made concave. Concave ceiling helps the sound wave to reflect and send to farther distance which makes the concert hall enable to send clear sound to the audience even sitting in back rows of hall.

Page 170

Question: 1 - What is the audible range of the average human ear?

Answer: 20 Hz to 20000 Hz

Question: 2 - What is the range of frequencies associated with

(a) Infrasound

(b) Ultrasound

Answer:

(a) Infrasound: Less than 20 Hz

(b) Ultrasound: More than 20000 Hz

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Question: 1 - A submarine emits a SONAR pulse, which returns from an underwater cliff in 1.02 s. If the speed of sound in salt water is 1531 m/s, how far away is the cliff ?

Answer: To return the SONAR pulse back, its wave has to travel two way.

Here, given,

Velocity (v) of sound wave = 1531m/s

Time (T) = 1.02 s

Thus, Distance = speed X time

Distance=1531 ms^(-1)×1.02 s=1561.62 m

So,the distance between the source and reflecting surface=1561.62÷2=780.81m

Exercise Questions (NCERT Book) – Sound Class nine

Question: 1 - What is sound and how is it produced?

Answer: Sound is a kind of energy produced in the form of waves. When anything is set to vibration, it produces sound.

Question: 2 - Describe with the help of a diagram, how compressions and rarefactions are produced in air near a source of sound.

Answer:-

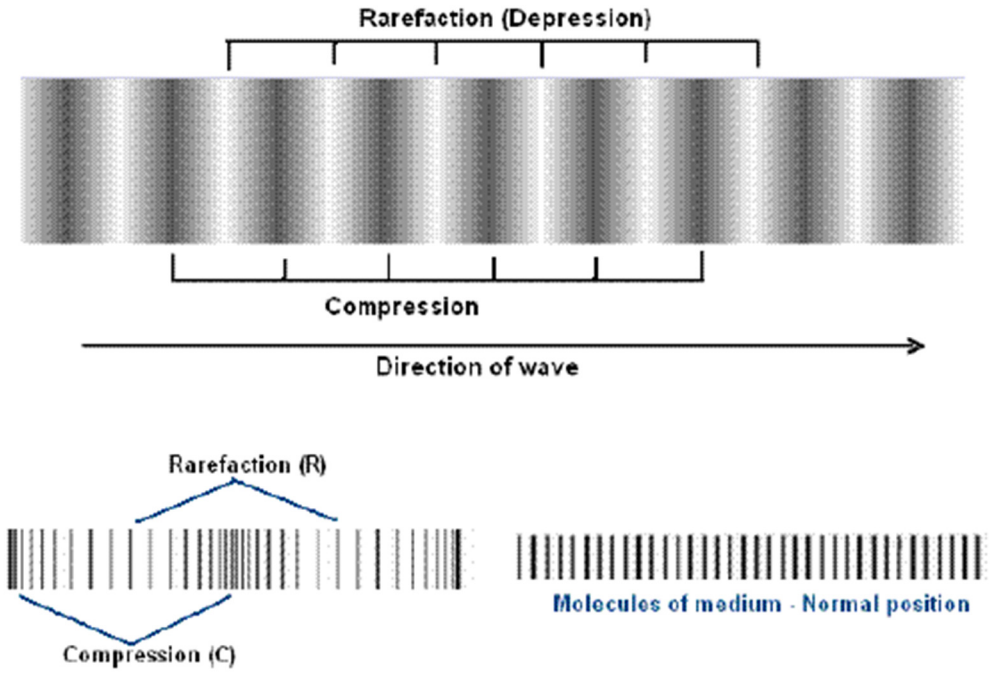
Compression and rarefaction in air – Compression and rarefaction are produced because of the disturbance in medium caused by sound wave. Sound wave propagates because of compression and rarefaction of the particles of the medium.

When an object starts vibrating, it creates disturbance in medium. Because of the disturbance particles of medium come closer to each other compare to their normal

position on the other hand adjacent particles go farther to each other. Both happen simultaneously.

The region where particles are come closer to each other is called compression and region where particles go farther to each other is called rarefaction.

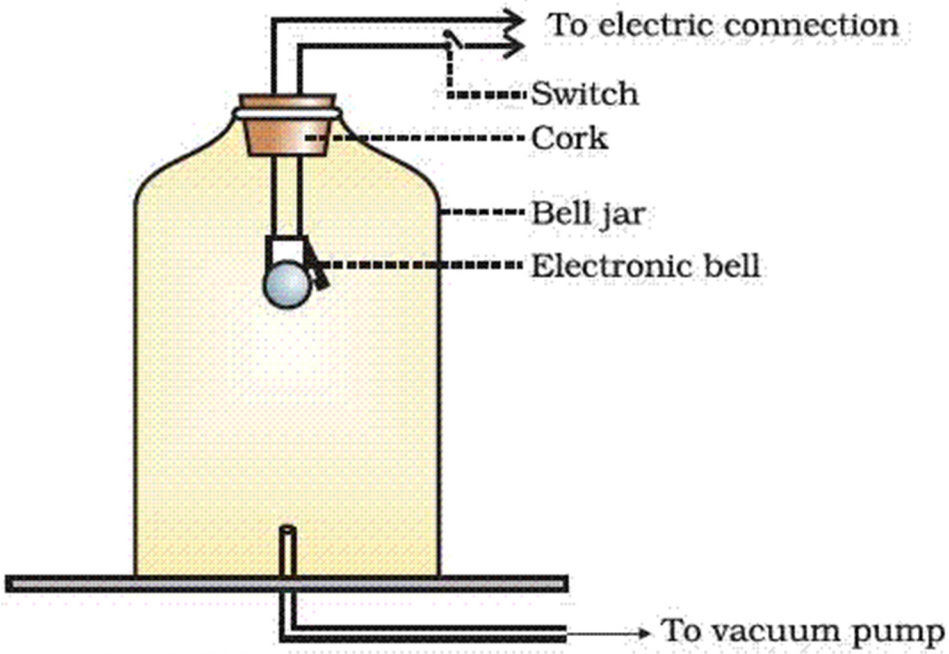
In the given figure straight lines are showing the normal position of air particles. Dense lines are showing the region of compression and less dense lines are showing region of rarefaction of air particles.



Question: 3 - Cite an experiment to show that sound needs a material medium for its propagation.

Answer:- Activity:-

- Take a glass bell jar, connect it with vacuum pump and suspend an electric bell in it.
- Connect electric bell with a battery.
- Switch on the electric bell and hear the sound of bell.
- Now remove the air completely from the bell jar using vacuum pump and observe the sound of electric bell.



Bell jar Experiment to show that medium is necessary for the propagation of sound

Ref: NCERT Book - Chapter - Sound

It is observed that sound of electric bell does not come out after pumping out air from the bell jar.

This happens because after creating vacuum in the bell jar there were no air present through which sound wave can propagate.

This experiment shows that without medium sound cannot propagate and hence for the propagation of sound medium must be present.

Question: 4 - Why is sound wave called a longitudinal wave?

Answer:

Since sound wave creates oscillation in the particles of the medium parallel to the disturbance in the direction of propagation, thus sound waves are called longitudinal wave. This would be more clear by taking the definition of longitudinal wave into account.

Longitudinal wave: When oscillation is created parallel to the disturbance of the particles of medium in the direction of propagation.

Question: 5 - Which characteristic of the sound helps you to identify your friend by his voice while sitting with others in a dark room?

Answer: Timbre and pitch are the characteristics of sound which help to identify the sound of different voice. Thus, because of difference in timbre and pitch of the sound wave I or any other can identify the voice of his friend sitting with others even in dark room.

Question: 6 - Flash and thunder are produced simultaneously. But thunder is heard a few seconds after the flash is seen, why?

Answer: This happens because of the difference in the velocity of light and sound waves. Light travels with much faster velocity than sound. That's why thunder is heard a few seconds after the flash of thunder is seen instead of both are produced simultaneously.

Question: 7 - A person has a hearing range from 20 Hz to 20 kHz. What are the typical wavelengths of sound waves in air corresponding to these two frequencies? Take the speed of sound in air as 344 m/s.

Answer:

Given, velocity of sound = 344 m/s

We know that

Velocity = wavelength X frequency

$$\Rightarrow Wavelength = \frac{Velocity}{Frequency}$$

Thus, in the case of sound of frequency of 20 Hz

$$Wavelength = \frac{344\ m/s}{20\ Hz} = 17.2\ m$$

In the case of sound of frequency of 20 kHz = 20000 Hz

$$Wavelength = \frac{344\ m/s}{20000\ Hz} = 0.00172\ m$$

Question: 8 - Two children are at opposite ends of an aluminium rod. One strikes the end of the rod with a stone. Find the ratio of times taken by the sound wave in air and in aluminium to reach the second child.

Answer:

We know that,

The speed of sound in air = 344 m per second

The speed of sound in aluminium = 5100 m per second

Hence, the ratio of time taken by the sound to travel through air and through aluminium

$$= \frac{Velocity\ of\ sound\ in\ aluminium}{Velocity\ of\ sound\ in\ air}$$

$$= \frac{5100\ m\ per\ second}{344\ m\ per\ second} = 150 : 1$$

Question: 9 - The frequency of a source of sound is 100 Hz. How many times does it vibrate in a minute?

Answer:

Given, frequency = 100 Hz

This means the source of sound vibrates 100 times in one second.

Therefore, number of vibrations in 1 minute, i.e. in 60 seconds = 100 x 60 = 6000 times.

Question: 10 - Does sound follow the same laws of reflection as light does? Explain.

Answer: Yes, the sound wave follows the same laws of reflection as the light does. The laws of reflection of sound are as follows:

- The incident sound wave, the reflected sound wave and the normal at the point of incident, all lie in the same plane.
- The angle of incidence of sound wave and angle of reflection of sound wave to the normal are equal.

When sound waves reflected from a surface, the angle of incidence is equal to the angle of reflection to the normal and the incident wave, normal and reflected wave are in the same plane. This can be proved by experiment.

Thus, sound wave obeys the laws of reflection.

Question: 11 - When a sound is reflected from a distant object, an echo is produced. Let the distance between the reflecting surface and the source of sound production remains the same. Do you hear echo sound on a hotter day?

Answer: To hear the sound of echo depends upon the distance from source of sound and reflecting surface. The distance between both must be equal to or more than 17.2 meter. If the given distance is more than 17.2 meter then one can hear the echo sound on a hotter day also.

Although, in hotter day the velocity of sound increases, thus it is necessary to hear the sound of echo the distance should be more than 17.2 meter. If the given distance is equal to 17.2, then to hear the sound in hotter day would not be possible.

Question: 12 - Give two practical applications of reflection of sound waves.

Answer: Bulb horn and Stethoscope are examples of practical applications of reflection of sound waves.

In bulb horn sound is amplified and sent to the desired direction because of reflection. In stethoscope also sound is sent to the desired direction because of its reflection characteristic.

Question: 13 - A stone is dropped from the top of a tower 500 m high into a pond of water at the base of the tower. When is the splash heard at the top? Given, g = 10 m^{-2} and speed of sound = 340 m/s.

Answer:

Given,

Height of tower = 500 m

g = 10m/s

Velocity of sound = 340 m/s^2

Thus, to calculate the time of splash sound, first of all time taken to reach the stone in the water is to be calculated.

We know that,

$$s = ut + \frac{1}{2}at^2$$

$$Or, s = ut + \frac{1}{2}gt^2$$

Here,

s = 500 m and g = 10 m/s^2

$$\Rightarrow 500\ m = 0 \times t + \frac{1}{2} \times 10\ ms^{-2} \times t^2$$

$$\Rightarrow 500\ m = 5ms^{-2} \times t^2$$

$$\Rightarrow t^2 = \frac{500m}{5m\ s^{-2}} = 100\ s^2$$

$$\Rightarrow t = 10\ s$$

Now, we know that the distance = speed X time

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

$$\Rightarrow Time = \frac{500m}{340\ ms^{-1}} = 1.47\ s$$

$$So, total\ time\ to\ hear\ the\ sound\ of\ splash = 10\ s + 1.47\ s = 11.47\ sec$$

Question: 14 - A sound wave travels at a speed of 339 m/s. If its wavelength is 1.5 cm, what is the frequency of the wave?

Answer:

Given,

Velocity (v) of sound = 339 m/s

Wavelength (λ) = 1.5 cm = 0.015 m

Frequency (v) =?

We know that, speed = wavelength X frequency

⇒339 m/s = 0.015 m X frequency

$$\Rightarrow Frequency = \frac{339\ m/s}{0.015\ m} = 22600\ Hz$$

Thus, frequency = 22600 Hz

Exemplar Problems (NCERT) and Solutions

Multiple Choice Questions

Question: 1 -Note is a sound

(a) of mixture of several frequencies

(b) of mixture of two frequencies only

(c) of a single frequency

(d) always unpleasant to listen

Answer: (a) of mixture of several frequencies

Question:- 2 - A key of a mechanical piano struck gently and then struck again but much harder this time. In the second case

(a) sound will be louder but pitch will not be different

(b) sound will be louder and pitch will also be higher

(c) sound will be louder but pitch will be lower

(d) both loudness and pitch will remain unaffected

Answer:- (d) both loudness and pitch will remain unaffected

Question: 3 - In SONAR, we use

(a) ultrasonic waves

(b) infrasonic waves

(c) radio waves

(d) audible sound waves

Answer: (a) Ultrasonic waves

Question:- 4 - Sound travels in air if

(a) particles of medium travel from one place to another

(b) there is no moisture in the atmosphere

(c) disturbance moves

(d) both particles as well as disturbance travel from one place to another.

Answer:- (c) Disturbance moves

Question: 5 - When we change feeble sound to loud sound we increase its

(a) Frequency

(b) Amplitude

(c) Velocity

(d) Wavelength

Answer: (b) Amplitude

Question: 6 - In the curve (Figure) half the wavelength is

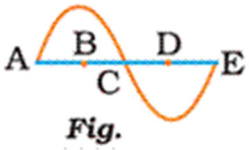


Fig.

(a) A B

(b) B D

(c) D E

(d) A E

Answer: (a) AB

Question: 7 - Earthquake produces which kind of sound before the main shock wave begins

(a) Ultrasound

(b) Infrasound

(c) audible sound

(d) none of the above

Answer: (b) Infrasound

Question: 8 - Infrasound can be heard by

(a) Dog

(b) Bat

(c) Rhinoceros

(d) human beings

Answer: (c) Rhinoceros

Question: 9 - Before playing the orchestra in a musical concert, a sitarist tries to adjust the tension and pluck the string suitably. By doing so, he is adjusting

(a) intensity of sound only

(b) amplitude of sound only

(c) frequency of the sitar string with the frequency of other musical instruments

(d) loudness of sound

Answer: (c) Frequency of the sitar string with the frequency of other musical instruments