Sound

Improve your learning

Q. 1. When we say sound travels in a medium
A. The medium travels
B. The particles of the medium travel
C. The source travels
D. The disturbance travels

Answer : When the source of sound vibrates it <u>creates disturbance</u> in the medium near it. And this <u>disturbance disturbs the neighboring molecules (of medium) with the help of previous molecules (of medium)</u>. And in this way the particles of medium travels.

Q. 2. A sound wave consists of
A. number of compression pulses only

B. number of rarefaction pulses only
C. number of compression and rarefaction pulses one after the other
D. vacuum only.

Answer : The sound wave travels through the series of compression and rarefactions that vary periodically. Therefore the sound wave consists of compression and rarefactions.

Q. 3. Hertz stands for oscillations per
A. second
B. minute
C. hour
D. milli second

Answer : Hertz is the S.I unit of the frequency and it is defined as the number of oscillations per second.

Q. 4. When we increase the loudness of sound of a TV, the property of sound that changes is
A. amplitude
B. frequency
C. wavelength
D. speed

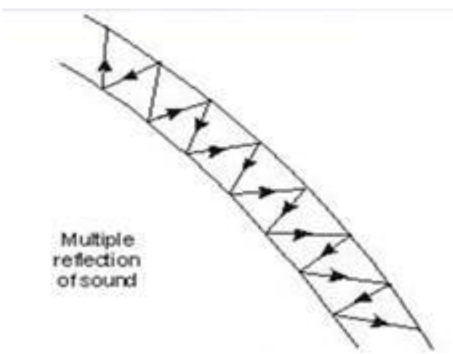
Answer : The amplitude of the wave determines the loudness, more the amplitude of the wave more is the loudness produced. While Frequency determines the pitch of the sound.

Q. 5. The characteristic of the sound that describes how the brain interprets the frequency of sound is called ( )
A. Pitch
B. Loudness
C. Quality
D. Sound

Answer : Pitch is the characteristics of sound that distinguish between shrill sound and growling sound. The sensation of pitch of sound is conveyed to our brain by sound waves that fall on our ears.

Q. 6. In a stethoscope, sound of heart beats travel through stethoscopes tube
A. By bending along the tube
B. In a straight line
C. Undergoing multiple reflections
D. all of the above

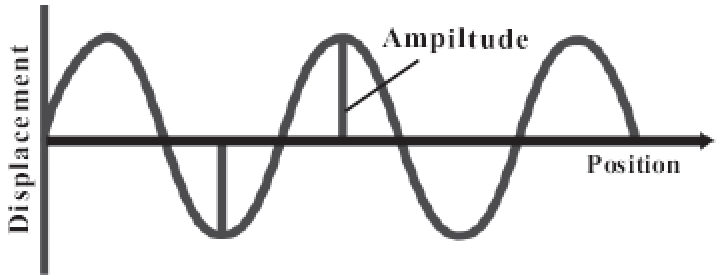
Answer : Sound can get reflected a number of times before reaching us. In multiple reflections of sound waves, they add up and the loudness increases. In a stethoscope, the sound of a patient's heart beat is guided along the tube to the doctor's ears by multiple reflections. The figure below describes the multiple reflections in stethoscope.



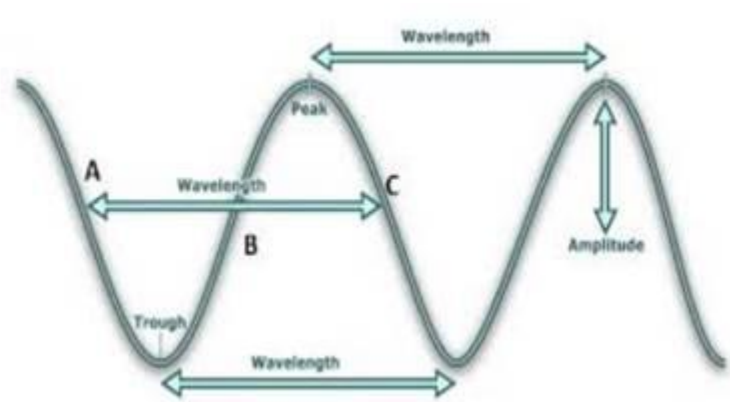
Q. 7. Explain the following terms

a) Amplitude
b) Wavelength
c) Frequency.

Answer : a. <u>Amplitude</u>: It is defined as the maximum displacement of particles in the medium on either side of the mean position. It is denoted by A. Its SI unit is meter. The figure below depicts the amplitude of the wave.



b. Wavelength: It is defined as the distance travelled by a wave during the time a particle of the medium completes one vibration. Or the distance between successive crests or troughs of a wave it is denoted by Greek letter 'λ' read as Lambda. Its SI unit is meter. The figure below illustrates the wavelength.



c. Frequency: The number of oscillations of the particle of the medium at a place per unit of time is called frequency of the sound wave. It is denoted by Greek letter 'v' read as nu. Its S.I unit is Hertz (Hz).

Q. 8. Deduce the relation between wavelength, frequency and speed of sound.

Answer : Let 'λ' be the wavelength and 'T' be the time period. 'v' be the speed of sound wave.

⇒ Wave travels distance 'λ' in time 'T'. (Because wavelength is the distance travelled by particle during particular time).

WE know that;

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

$\Rightarrow v = \frac{\lambda}{T}$ (Distance travelled in time 'T' = wavelength (λ).)

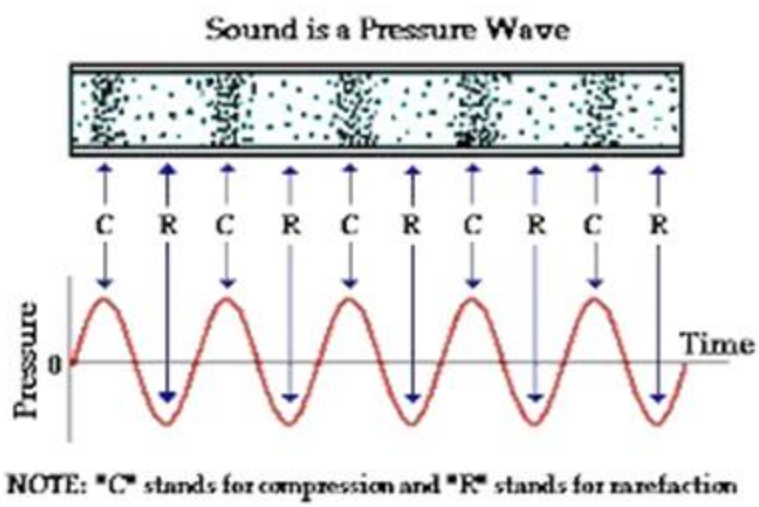
$\Rightarrow v = \lambda\nu$

($\because$ Frequency (ν) = $\frac{1}{\text{Time period(T)}}$)

∴ Speed of sound wave = Frequency × Wavelength

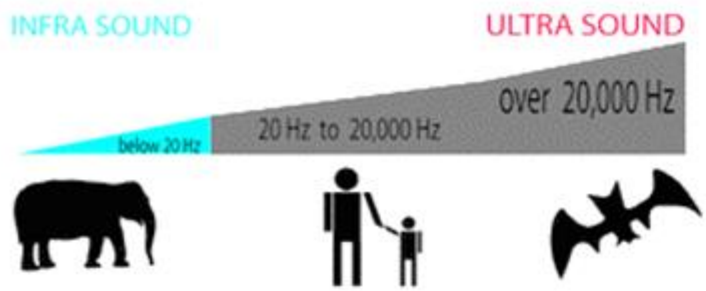
Q. 10. Name two quantities that vary periodically at a place in air as a sound wave travels through it.

Answer : The series of compression and rarefaction vary periodically at place in air as sound travel through it. Compression is the region where the density as well as pressure of the air is very high. Rarefaction is the region where the density as well as the pressure is very low. The Figure below shows the compression and rarefaction as the sound travels in a medium.



Q. 11. Which has larger frequency – infrasonic sound or ultrasonic sound?

Answer : Ultrasonic sound have higher frequency than infrasonic sound. Because Infrasonic sound are the sound waves with frequency less than 20 Hz (hertz).While Ultrasonic sound are the sound waves having frequency higher than 20 kHz. The figure below depicts more clearly the frequency range of infrasonic and ultrasonic sound waves.



Q. 12. The grandparents and parents of two-year old girl are playing with her in a room. A sound source produces a 28-kHz sound. Who in the room is most likely to hear the sound?

Answer : No one can hear the sound because the range of human hearing is between 20 Hz to 20,000 Hz. While the sound produced is of frequency 28,000 Hz which is more than the upper limit of human hearing range. It is ultrasonic sound wave.

Q. 13. Does the sound follow same laws of reflection as light does?

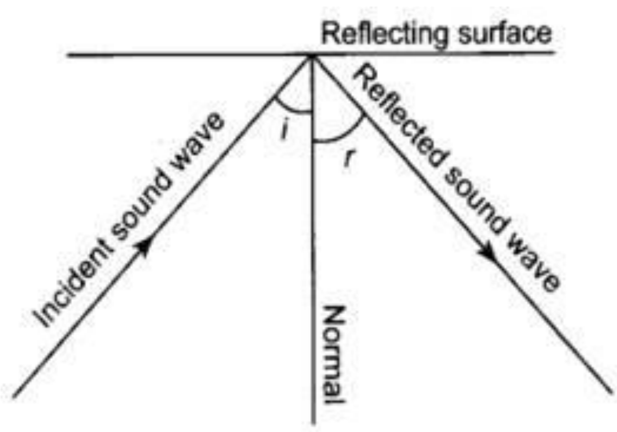
Answer : Yes, the sound wave follows the same laws of reflection as the light does. The laws of reflection of sound are as follows:

1. The incident sound wave, the reflected sound wave and the normal at the point of incident, all lie in the same plane.

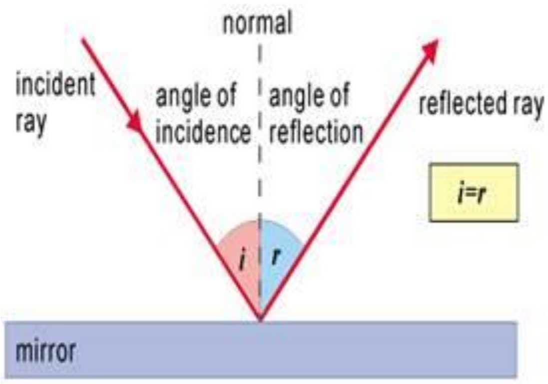
2. The angle of incidence of sound wave and angle of reflection of sound wave to the normal are equal.

The same laws hold in the reflection of light. The Incident ray, reflected ray and normal lie in the same plane and angle of incidence is equal to angle of reflection.

The figure below depicts the reflection of sound and light.



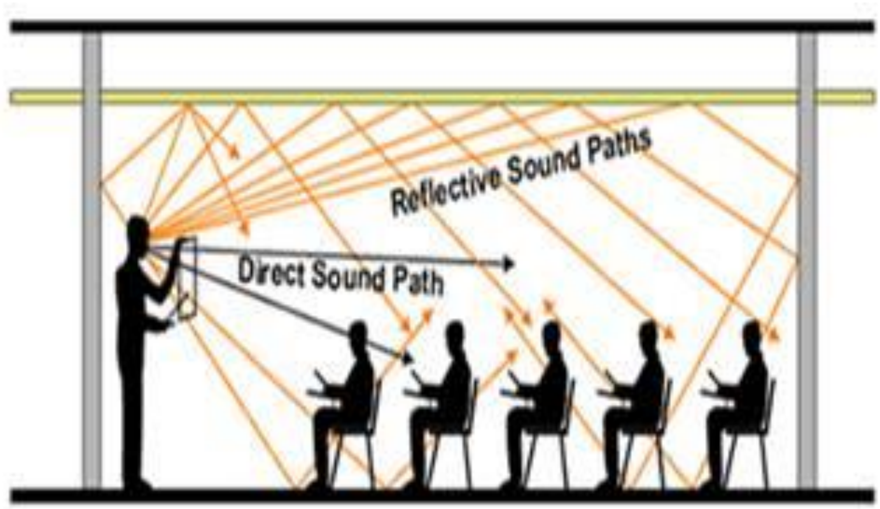
Reflection of Sound Waves.



Reflection of Light

Q. 14. Why is soft furnishing avoided in concert halls?

Answer : Soft furnishing leads to reverberation which causes multiple reflections of sound due to which higher frequency sounds bouncing off walls, floors and ceilings and arriving at your ears just slightly later than the direct sound and this adversely affect the quality of the sound, Hence avoiding soft furnishing in concert halls reduces the reverberation and quality of sound is improved. The figure below depicts the effect of soft furnishing.



Q. 15. Two sources A and B vibrate with the same amplitude. They produce sounds of frequencies 1 kHz and 30 kHz respectively. Which of the two waves will have larger power?

Answer : The power of the sound wave is directly proportional to the Frequency.

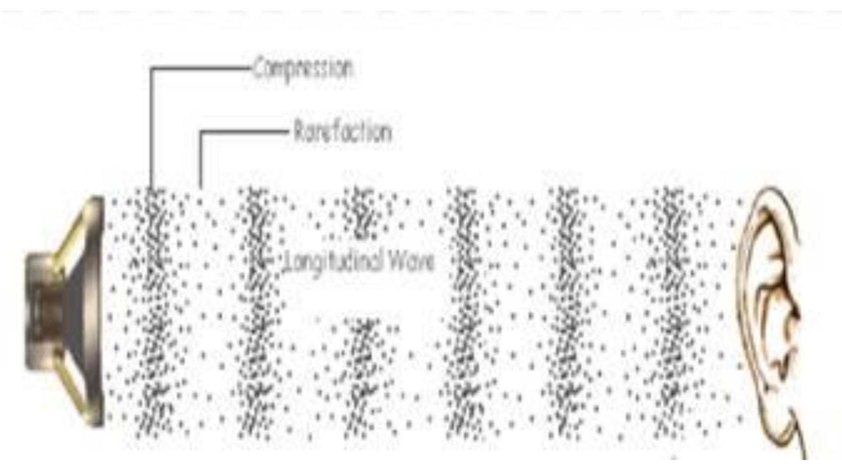
∴ The sound wave having high frequency will have more energy.

⇒ Sound of Frequency 30 KHz has more energy than sound of 1 kHz.

Q. 16. What do you understand by a sound wave?

Answer : A sound wave is the pattern of disturbance caused by the movement of particles traveling through a medium (such as air, water, or any other liquid or solid matter) as it propagates away from the source of the sound. The source is some object that causes a vibration, such as a ringing telephone, or a person's vocal chords. The vibration disturbs the particles in the surrounding medium; those particles disturb those next to them, and so on. The sound waves travel in medium through compression and rarefactions.

Sound waves are Longitudinal Waves which means that particles of the medium moves in the direction of propagation of the wave. The figure below depicts how the sound wave travels.



Q. 17. Define the wavelength of a sound wave. How is it related to the frequency and the wave speed?

Answer : <u>Wavelength</u>:

Wavelength is the distance travelled by a wave during the time a particle of the medium completes one vibration. It is also defined as the distance between successive crests or troughs of a wave. It is denoted by Greek letter ‘λ’ read as Lambda. Its SI unit is meter.

<u>Relation with Frequency and Wave speed</u>:

Wave speed (v) = Wavelength (λ) × Frequency (v).

The derivation of the above relation is as follows.

We know that;

$$\text{Wave sped} = \frac{\text{Distance}}{\text{Time}}$$

∵ Wavelength (λ) = distance travelled in time 'T'.

$$\Rightarrow v = \frac{\lambda}{T}$$

Also

∵ Frequency (ν) = $\frac{1}{\text{Time period(T)}}$

$\Rightarrow v = \lambda\nu$

Hence Wave speed (v) = Wavelength (λ) × Frequency (v).

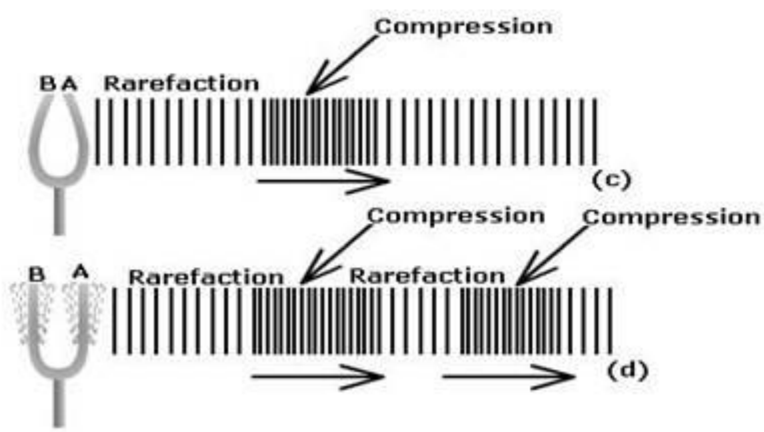
Q. 18. Explain how echoes are used by bats to judge the distance of an obstacle in front of them.

Answer : To help them find their prey in the dark, most bat species have developed a remarkable navigation system called echolocation. Bats use echo in this process .A bat emits a ultrasound waves and listens carefully to the echoes that are returned. The ultrasound pulses are not echoed if way is clear. The bat's brain processes the returning information the same way we processed our shouting sound using a stopwatch and calculator. By determining how long it takes a noise to return, the bat's brain figures out how far away an object is. They compare the volume of echoes in their right and left ears, and turn away from the louder echo, since that obstacle would presumably be nearer this method allowed bats to avoid obstacles using just the first millisecond of the echo as a signal.

The figure below depicts the whole process.

Q. 19. With the help of a diagram describe how compression and rarefaction pulses are produced in air near a source of sound.

Answer : When a vibrating object moves forward, it pushes the molecules of the air in front of it and create region of high pressure and high density called Compression. As the compression produced in the air travels forward, the Vibrating body moves backward. They create a region of low pressure and low density in the Air commonly called rarefaction. The compression and rarefaction causes the particles in air to vibrate about their mean position. The Figure below illustrates the formation of compression and rarefaction by Tuning fork.

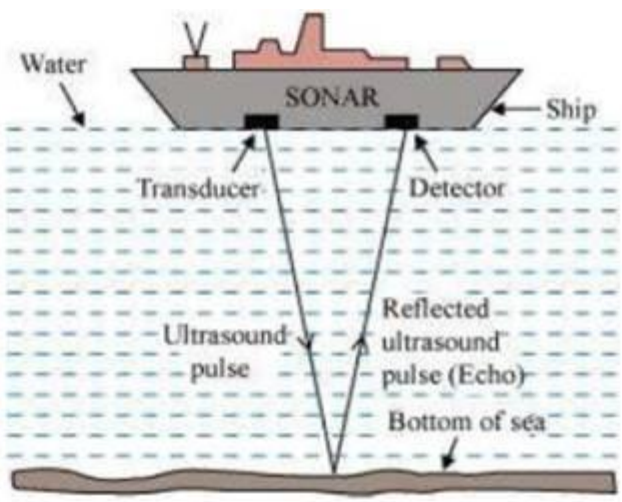


Q. 20. How do echoes in a normal room affect the quality of the sounds that we hear?

Answer : For a distinct echo to take place, the minimum distance between the source of sound and the reflector must be 17.2 meters at a particular temperature in the air. The persistence of sound is 0.1 seconds. Since the distance between the walls and ceilings of a small room from the source of sound is less than 17.2 meters, the reflected sound is produced 0.1 second before the original sound. Due to this, a prolonged sound is heard in place of an echo which is called reverberation. Due to multiple reflections we hear same sound many times.so this persistence of sound creates a problem in listening words separately. The sound we hear comes many no of times and this is how our brain is confused to recognize the sound.

Q. 21. Explain the working and applications of SONAR.

Answer : Working: SONAR is an acronym for Sound Navigation and Ranging. A beam of ultrasonic sound is produced and transmitted by the transducer (it is a device that produces ultrasonic sound) of the SONAR, which travels through sea water. The echo produced by the reflection of this ultrasonic sound is detected and recorded by the detector, which is converted into electrical signals. The distance (d) of the under-water object is calculated from the time (t) taken by the echo to return with speed (v) is given by $2d = v \times t$. This method of measuring distance is also known as 'echo-ranging'. The figure below illustrates the working.



Applications

1. Used to measure the depth, direction, and speed of under-water objects such as submarines and ship wrecks.

2. It is also used in military for detecting the presence of enemy ships.

Q. 22. Find the period of a source of a sound wave whose frequency is 400Hz.)

Answer : We know that;

$$\text{Time Period} = \frac{1}{\text{frequency}}$$

In our question;

Frequency = 400 Hz.

∴ $\text{Time Period} = \frac{1}{400}$

⇒ Time Period = 0.0025 s.

Q. 23. A sound wave travels at a speed of 340 m/s. If its wavelength is 2cm, what is the frequency of the wave? Will it be in the audible range?

Answer : It is given that,

Velocity (v) of sound = 339 m/s.

Wavelength (λ) = 1.5 cm = 0.015 m.

Frequency (v) =?

<u>We know that, speed = wavelength × frequency</u>

⇒ 340 m/s = 0.015 m × frequency

⇒ Frequency = $\frac{340}{0.015}$ = 22666.66 Hz

⇒ Frequency = 22666.66 Hz.

∵ Audible frequency range is from 20 Hz to 20000 Hz

Hence the freq. is beyond 20000 Hz so it is not audible.

∴ the above sound is not audible.

Q. 24. Given that sound travels in air at 340 m/s, find the wavelength of the waves in air produced by a 20kHz sound source. If the same source is put in a water tank, what would be the wavelength of the sound waves in water? Speed of sound in water = 1,480 m/s.

Answer : <u>Case 1</u>:

It is given that,

Velocity (v) of sound = 340 m/s.

Wavelength (λ) =?

Frequency (v) = 20 kHz = 20000 Hz (∵ 1 kHz = 1000 Hz.)

We know that, speed = wavelength × frequency

⇒ 340 m/s = wavelength × 20000

⇒ Frequency = $\frac{340}{20000}$ = 0.017 m.

⇒ Wavelength = 0.017 m.

Case 2:

If the sound source is put in a water tank, the frequency of the waves remains unchanged.

∴ According to the question

Velocity (v) of sound = 1480 m/s.

Wavelength (λ) =?

Frequency (v) = 20 kHz = 20000 Hz (∵ 1 kHz = 1000 Hz.)

We know that, speed = wavelength × frequency

⇒ 1480m/s = wavelength × 20000

⇒ Frequency = $\frac{1480}{2000}$ = 0.074 m.

⇒ Wavelength = 0.074 m.

Q. 25. A man is lying on the floor of a large, empty hemispherical hall, in such a way that his head is at the centre of the hall. He shouts "Hello!" and hears the echo of his voice after 0.2 s. What is the radius of the hall? (Speed of sound in air = 340 m/s)

Answer : Since the man receives the echo after 0.2 seconds. And echo is returned after reflection from the walls of hall.

∴ Time taken by sound wave to travel to wall of hall is 0.1 s

⇒ Time (T) = 0.1 s

Speed (v) of sound in air = 340 m/s)

We know that $\text{Speed} = \frac{\text{Distance}}{\text{Time}}$

$$\Rightarrow 340 = \frac{D}{0.1} = 10D$$

$$\Rightarrow D = \frac{340}{10} = 34\text{m.}$$

Hence the distance travelled by sound wave is 34 m.

∵ the hall is hemispherical therefore the distance of the man from the walls of the hall is same and is equal to the radius of the hall.

Hence radius of hall is 34 m.

Q. 26. "We know that sound is a form of energy. So, the large amount of energy produced due the sound pollution in cosmopolitan cities can be used to our day to day needs of energy. It also helps us to protect bio diversity in urban areas". Do you agree with this statement? Explain.

Answer : As the energy can neither be created nor be destroyed but can be transformed from one form to other. And sound is also one of the forms of energy; Therefore It is possible to produce energy from sound. Sound consists of electromagnetic waves which contain energy; the problem is we do not have the knowledge to convert that energy into something more useful. So the answer is YES, and deeper study on the subject is required to achieve it.

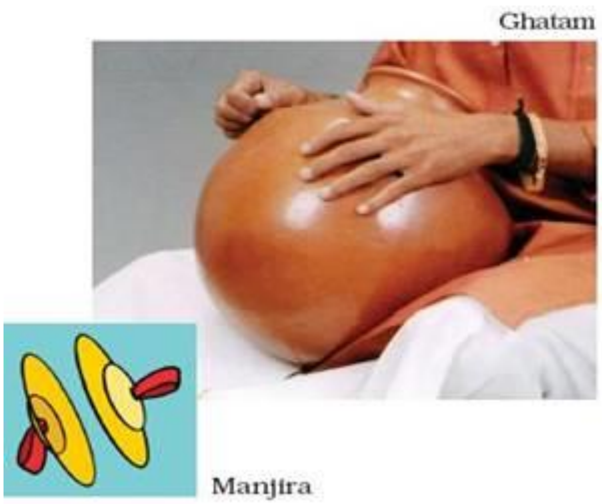
It may be possible if we can concentrate sound at some particular point by refraction, total internal reflection or some other phenomena of sound .The blast of sound can create music, noise and destruction. With a collector or energy-absorbing panel adapted to the sound, you can save this energy.

Also the biodiversity in area can be protected because high levels of sound causes damage to their ears and also cause other disorders. Thus using the energy to produce other forms of energy can reduce the high levels of sound in that area and thereby will protect the bio diversity.

Q. 27. How do you appreciate efforts of a musician to produce melodious sound using a musical instrument by simultaneously controlling frequency and amplitude of the sounds produced by it.

Answer : Quality or timbre is that characteristic of musical sound which enables us to distinguish between the sounds of same pitch an loudness produced by different musical instruments or different persons. The difference in the quality of two musical sounds produced by two musical instruments is due to the difference in the shapes of sound waves or waveforms produced by them.

Many of us might have seen the manjira (cymbals), the ghatam, and the noot (mudpots) and the kartal. These instruments are commonly used in many parts of our country. These musical instruments are simply beaten or struck .The figure below depicts these instruments.



When the musician plucks the string of an instrument, like the sitar, the sound that we hear is not only that of the string. The whole instrument is forced to vibrate, and it is the sound of the vibration of the instrument that we hear. Similarly, when musician strike the membrane of a mridangam, the sound that we hear is not only that of the membrane but of the whole body of the instrument.

The figure below depicts the Mridangam and Sitar.

Q. 28. You might have observed that sometimes your pet dog starts barking though no one is seen near in its surroundings or no disturbance heard nearby. Does this observation raise any doubts in your mind about the peculiar behavior of dog after your understanding about 'range of hearing the sound'. If yes, write them.

Answer : Dogs can hear the sound ranging from 67 Hz to 45000 Hz. Therefore it can also hear the ultrasonic sound waves. When there is other creature or anything that produces ultrasound waves the dog detects it and starts barking to warn us. We humans can hear sound waves from 20 Hz to 20000 Hz hence we can't hear the sound waves that can be heard by dog.

Project work

Q. 1. Find out the information about names of animals and their photographs from internet, which communicate using infra-sonic or ultra-sonic sound and prepare a scrap book.

Answer : Animals that communicate through infra sonic or ultra-sonic are whales, elephants, hippopotamuses, rhinoceros, giraffes, okapi, and alligators

1. Below is an image showing the whale using ultra sonic waves in the water to communicate with other fishes.

When the sound hits the object in the water it bounces back as an echo and whales absorb this echo.

2. Bats use ultrasound to find and catch insects. The phenomenon is called as echolocation. Some species are better at it than others.

3. When male mice perceive the pheromones of a female counterpart, they respond with ultrasonic sounds.