12. Sound

Assess Yourself

1. Question

Expand SONAR.

Answer

SONAR is an acronym for Sound Navigation and Ranging. It is used to measure the depth, direction, and speed of under-water objects such as submarines and ship wrecks.

2. Question

How is pitch of sound related to its frequency?

Answer

The pitch of the sound we hear depends on the frequency of the sound wave. A high frequency sound wave has a high pitch, and a low frequency sound has a low pitch

3. Question

Which part of drum vibrates to produce sound?

Answer

Membrane of the drum vibrates to produce the sound. When the membrane is struck it generates a movement of air the shell amplifies the sound of the drum head developing into a sound wave

4. Question

How does the velocity of sound change when medium changes from air to water?

Answer

When sound travels from one medium to another, both its velocity and the wavelength changes. When the sound travels from air to water the speed of the sound increases.

5. Question

How is ultrasound used in cleaning?

Answer

Ultrasonic cleaning is the rapid and complete removal of contaminants from objects by immersing them in a tank of liquid flooded with high frequency sounds waves. These non-audible sound waves create a scrubbing brush action within the fluid.

6. Question

Define reverberation.

Answer

Reverberation is the phenomenon of overlapping of sound caused by multiple reflections**. It** causes the overlapping of several reflected waves. If the time gap between the reflected waves is so short that these cannot be distinguished. So we hear multiple noisy sounds.

7. Question

Name two animals which produce ultrasound.

Answer

Ultrasonic waves are the sound waves with frequency more than 20 kHz. Animals like dolphins, bats and dogs produce ultrasound.

8. Question

An echo is returned in 6 seconds. What is the distance of reflecting surface from source? [given that speed of sound is 342 m/s.]

Answer

Given

Speed of sound (u) = 342 m/s

Time taken for hearing the echo (t) = 6 s

Now

$$speed = \frac{distance}{time}$$

$$\Rightarrow 342 = \frac{distance}{6}$$

⇒ Distance travelled by the sound = 342 ×6 = 2052 m.

In 6s, sound has to travel twice the distance between the source and reflecting surface. Therefore, the **distance of the reflecting surface from the source =** $\frac{2052}{2}$ **= 1026 m**

Distance of reflecting surface = 1026 m

9. Question

Aditi clapped her hands near a cliff and heard the echo after 4 seconds. What is the distance of the cliff her if the speed of sound is taken as 346 ms^{-1}.

Answer

Given

Speed of sound (u) = 346 m/s

Time taken for hearing the echo (t) = 4s

Now

$$speed = \frac{distance}{time}$$

$$\Rightarrow 346 = \frac{distance}{4}$$

⇒ **Distance travelled by the sound = 346 ×4 = 1384 m.**

In 4 s, sound has to travel twice the distance between the cliff and aditi.

Therefore, the **distance between the cliff and aditi is =** $\frac{1384}{2}$ **= 692 m**

Distance of cliff from aditi = 692 m

10. Question

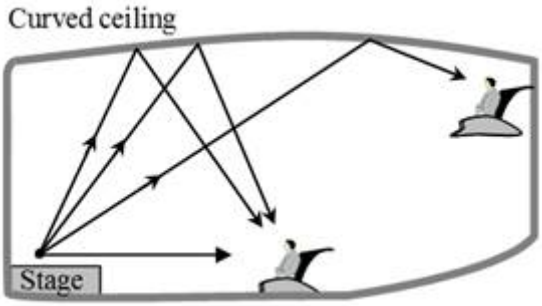
Describe two uses of multiple reflections of sound.

Answer

Multiple reflection of sound is used in various appliances and devices. The examples are as follows:

1. Stethoscope => A medical instrument used for listening the sound produced by heart or lungs. The sounds of heartbeat reach the doctor ear by multiple reflections and amplify the sound. The figure below describes multiple reflections in stethoscope.

2. Designing of Concert Halls => The ceilings of concert halls, conference hall and cinema halls are designed such that sound undergoes multiple reflections and reaches all corners of the hall. Some halls have a curved ceiling for the same. The figure below depicts the multiple reflections in concert hall.



11. Question

Find the distance between a surface and the source of sound, if speed of sound is 334 m/s and echo returns from the surface in 1.5 s.

Answer

Given

Speed of sound (u) = 334 m/s

Time taken for hearing the echo (t) = 1.5s

Now

$$speed = \frac{distance}{time}$$

$$\Rightarrow 334 = \frac{distance}{1.5}$$

⇒ Distance travelled by the sound = 334 ×1.5 = 501 m.

In 1.5 s, sound has to travel twice the distance between the source and surface. Therefore, the **distance between the source and surface is =** $\frac{501}{2}$ **=**

250.5 m

Distance of source from surface = 250.5 m

12. Question

Why can't we hear the sound of squeaks produced by bats?

Answer

Bat uses echolocation to sense movement and their surroundings. We cannot hear the high pitched noise they emit because it is of a frequency higher than what the human can hear. There are some sounds of bat that we can hear but we can't hear squeaks because their frequency comes in the range of ultrasound (more than 20 kHz) and we can hear between 20 Hz to 20 kHz only.

13. Question

Ocean waves of time period 0.01s have a speed of 15 m/s. Calculate the wavelength of these waves. Find the distance between the adjacent crest and the through.

Answer

Given

Time Period (t) = 0.01 s;

Speed of wave (v) = 15m/s;

We know that

Wavelength = speed × time

⇒ Wavelength = $15 \times 0.01 = 0.15\ m$

Distance between adjacent crest and trough = $\frac{wavelength}{2}$

= $\frac{0.15}{2} = 0.075\ m$

Hence

Wavelength = 0.15m

Distance between adjacent crest and trough = 0.075m

14. Question

Define (a) pitch (b) quality (c) loudness of sound.

Answer

(a) 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

(b) 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.

(c) **Loudness** refers to how loud or soft a sound seems to a listener. The loudness of sound is determined, in turn, by the intensity of the sound waves.

15. Question

Explain how human car works in the transmission of sound wave to the brain.

Answer

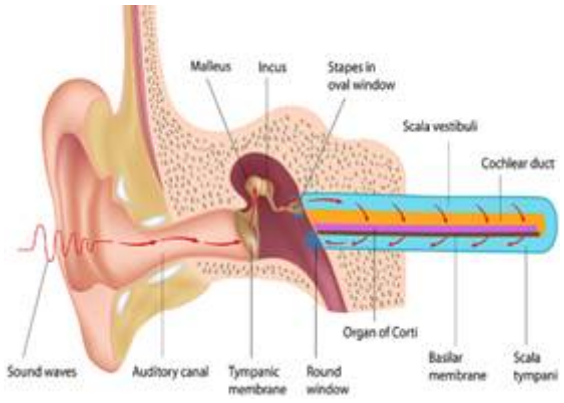
The collected sound from the surroundings is passed, through the auditory canal. At the end of the auditory canal, there is a thin membrane called EARDRUM.

When a compression of the medium reaches the eardrum, the pressure on the outside of the membrane increases and forces the eardrum inward. Similarly, the eardrum moves outward where a rarefaction reaches it. In this way eardrum vibrates.

The middle ear transmits' these pressure variations received from the sound wave to the inner ear, the pressure variations are turned into electrical signals by the cochlea.

These electrical signals are sent to the brain via the auditory nerve and the brain interprets them as sound.

Figure below shows the diagram for the ear.



16. Question

(a) Draw a diagram to represent a sound wave.

(b) How does sound produced by a source reach our ears?

Answer

Figure below represents the sound wave of Small amplitude

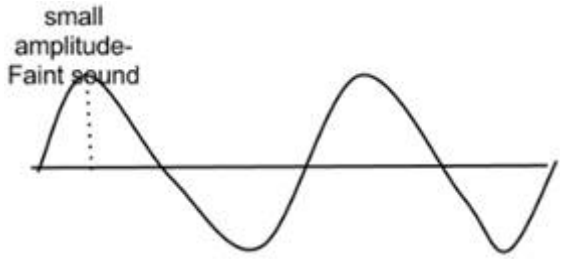


Figure below represents the sound wave with high amplitude.

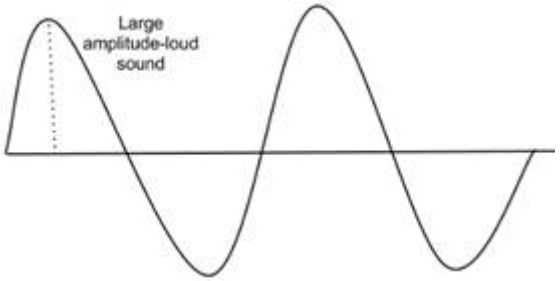


Figure below represents the sound wave with high pitch.

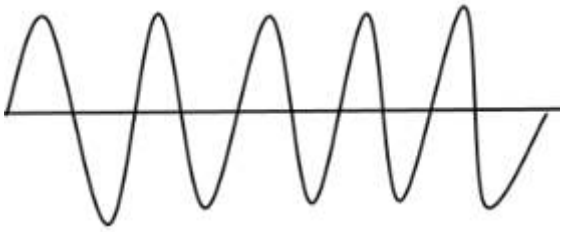
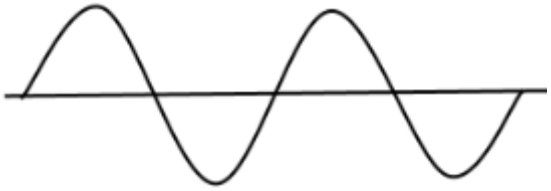


Figure below represents the sound with low pitch.



(b) Sound reaches our ears in the form of transverse waves or vibrations from its source of production.

A vibrating object creates compression and rarefaction of the surrounding air molecules, and those sound pressure waves in the air in turn cause the tympanic membrane in your ears to vibrate.

17. Question

(a) What is an echo?

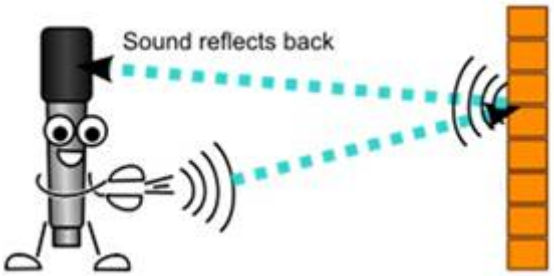
(b) How is an echo different from a reverberation?

(c) Describe an activity to demonstrate that sound follows the same laws of reflection as light.

Answer

The repetition of the sound, which is reflected from a high building or any such surface, is called an echo. An echo can be heard only when the distance between the source of sound and the reflecting body is at least 17 m.

Figure below illustrates it more clearly.



For Example when a person shouts in a big empty hall he listens to his sound repeatedly.

(b) Following are the difference between echo and reverberation.

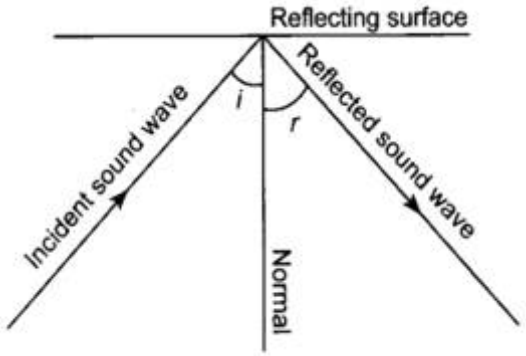
Echo	**Reverberation**
1. Echo is a single reflection of a sound wave off a surface	Reverberation is the sound or the pattern created by the superposition of such echoes.
2. An echo can be heard only when the distance between the source of sound and the reflecting body is at least 17 m	Reverberation can occur when sound wave is reflected by a nearby wall also.

3. An echo is usually clear and can be clearly distinguished	Reverberation is not a clear replica of the original sound sample.
4. Echo can be used to determine the distance of a reflecting object such as a large building or a mountain, if the ambient temperature is known	Reverberation cannot be utilized for distance measurement applications
5. An echo can be heard both in open and closed spaces	Reverberation is usually experienced in closed spaces with multiple reflecting objects.

(c) The **laws of reflection** are the following:

1. The angle of incidence is equal to the angle of reflection.

2. The incident ray, the normal at the point of incidence and the reflected ray - all lie in the same plane.



Activity:

Materials required: a drawing board, a white sheet of paper, a few common pins, a protractor, pencil, eraser and a plane mirror.

Method:

1. Fix the white sheet of paper firmly on the drawing board. Place the plane mirror on it and trace its outline on the paper.

2. Remove the mirror and draw the normal.

3. Now place the mirror again on the outline. The normal will be reflected clearly on the mirror.

4. Next place two pins in a straight line on one side of the normal on the white sheet of paper.

5. Next place two pins on the other side of the normal in such a way that these two pins is in a straight line with the reflection of the two pins on the other side of the normal.

6. Now remove the mirror and the pins and join the pin marks to the normal.

7. Measure the angle of incidence and the angle of reflection. Both will be equal, proving the first law of reflection.

Result: Since the lines representing the normal, the incident ray and the reflected ray are all represented on the same sheet of paper, the second law is also verified.

18. Question

Shirin went to an opera house. She appreciated its architecture and furnishing. The curved ceiling draperies, cushions and curtains were perfectly placed. She also saw sound board behind the stage. She now wondered if each of these accessories were placed for the sake aesthetics of the hall or had a scientific reason too.

(a) What is the purpose of curtains, cushions and draperies in an opera house?

(b) How des curved ceiling and sound board help?

(c) List some characteristic qualities of Shirin.

Answer

(a) Curtains, draperies and cushions are sound absorbent materials, they reduce reverberation.

(b) Sound boards and curved cutting focuses the sound such that sound after reflection reaches all corners of the hall and spreads evenly across the width of the hall.

Also to avoid the reverberation the walls and roof of the hall are made curved so that sound waves don't suffer multiple reflections and quality of sound improves.

(c) Shirin is curious, scientific and intelligent.