Chapter-11

Sound

EXERCISE-11.1
1 mark

1. How does the sound produced by a vibrating object in a medium reach your ear.

Ans. As we speak, the particles of air near our mouth are pushed forward so they get compressed. Then they compress the other particles of air. As the compression proceeds the particles of air near our mouth expand again and thus rarefaction occurs. This process is repeated further and as a result sound wave propagates in the form of compressions and rarefactions to the listener's ear.

2. Explain how sound is produced by your school bell.

Ans. When the peon strikes the school bell with a hammer, the particles of bell metal start vibrating and those vibrations produce sound.

3. Why are sound waves called mechanical waves?

Ans. Since sound waves need a medium for their propagation therefore we can say that sound waves are mechanical waves

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

Ans. There is no air on moon hence there is no medium for sound propagation on moon. As a result, me and my friend will not be able to hear any sound produced by my friend.

5. Which wave property determines

a loudness,

b pitch?

Ans. a The amplitude of the wave determines loudness of sound.

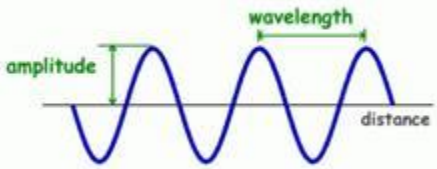
b The frequency of the wave determines pitch of sound.

EXERCISE-11.2
2 mark

1. What are wavelength, frequency, time period and amplitude of a sound wave?

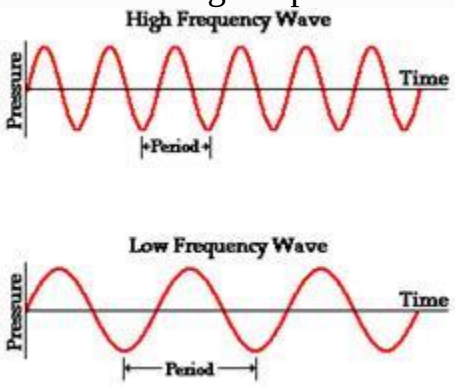
Ans. wavelength: For a sound wave, the combined length of a compression and an adjacent rarefaction is called its wavelength even the distance between centres of two consecutive compressions or two consecutive rarefactions is also equal to its wavelength.

frequency: The number of vibrations or oscillations per second is called frequency i.e. it is the number of complete waves or cycles produced in one second.



time period: The time taken to complete one vibration/oscillation/complete wave is called time period. It is measured in seconds.

amplitude: It is the maximum displacement of the particles of the medium from their mean/original position at rest.



2. How are the wavelength and frequency of a sound wave related to its speed?

Ans. From the equation: $v = n \times \lambda$
where v = velocity/speed

n = frequency of wave

λ = wavelength of wave

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

Ans. Since we know $v = n \times \lambda$

$440 = 220 \times \lambda$

λ = 440/220 = 2 m

4. 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?

Ans. The time interval between successive compressions from the source
T = 1/ν = 1/500 = 0.002 second.

5. Distinguish between loudness and intensity of sound.

Ans.

Loudness of sound	Intensity of sound
It is a subjective measurement of sound energy. It is a sensation as perceived by our ears. It depends upon intensity of sound near the ear.	It is an objective measurement of sound energy(amount of sound energy passing each second through unit area) and it determines the loudness of sound produced from any source.

6. In which of the three media, air, water or iron, does sound travel the fastest at a particular temperature?

Ans. Sound will travel the fastest in iron at a particular temperature.

7. An echo returned in 3 s. What is the distance of the reflecting surface from the source, given that the speed of sound is $342\ m\ s^{-1}$?

Ans. Speed of sound = distance/time

therefore, distance travelled by sound during echo = $speed \times time = 342 \times 3$ = 1026 m

so the distance of reflecting surface = 1026/2 =513 m

8. Why are the ceilings of concert halls curved?

Ans. The ceilings of concert halls are curved because such architecture helps the sound to reach all the corners and places of concert hall.

1. What is the audible range of the average human ear?

Ans. 20 Hz to 20,000Hz.

EXERCISE-11.3
4 mark

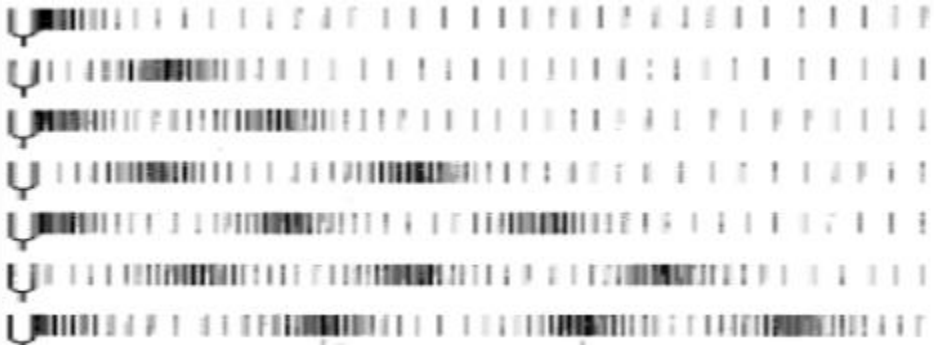
1. What is the range of frequencies associated with
a Infrasound?
b Ultrasound?
Ans. Infrasound = less than 20 Hz
Ultrasound = greater than 20 KHz

2. 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?
Ans. Distance travelled by a sonar pulse = speed of sound in salt water × time
$= 1531 \times 1.02 = 1561.62$ m

therefore, the distance of cliff from submarine = 1561.62/2 = 780.81 m

3. What is sound and how is it produced?
Ans. Sound is a form of energy that produces a sensation of hearing in our ears. Sound gets produced when any object vibrates/oscillates.

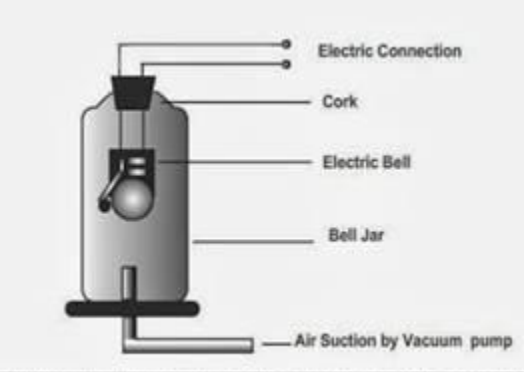
4. Describe with the help of a diagram, how compressions and rarefactions are produced in air near a source of sound.
Ans.



5. Cite an experiment to show that sound needs a material medium for its propagation.

Ans. Take an electric bell and an airtight glass bell jar. The electric bell is suspended inside the airtight bell jar. The bell jar is connected to a vacuum pump If you press the switch you will be able to hear the bell. Now start the vacuum pump. When the air in the jar is pumped out gradually, the sound becomes fainter, although the same current is passing through the bell.

After some time when less air is left inside the bell jar you will hear a very feeble sound. Now if we evacuate the bell jar no sound is heard.



Bell jar experiment showing sound needs a material medium for its propagation.

Result: The above mentioned activity shows that sound needs a medium to propagate.

6. Why is sound wave called a longitudinal wave?

Ans. Sound wave is called a longitudinal wave because sound waves travel in the air through compressions and rarefactions.

7. Which characteristic of the sound helps you to identify your friend by his voice while sitting with others in a dark room?

Ans. Pitch of the sound wave.

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

Ans. Since speed of thunder sound is much less 332 m/s as compared to speed of flash light which is about $3\times10^{8} m/s$ therefore light travels faster than sound hence thunder is heard a few seconds after the flash is seen.

9. 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 $344\ m\ s^{-1}$.

Ans. For 20 Hz sound waves the wavelength would be

$v = n \times \lambda$

λ = v/n = 344/20 = 17.2 m

For 20 kHz sound waves the wavelength would be

$v = n \times \lambda$

$\lambda = v/n = 344\ ms^{-1}$/20000 Hz = 0.0172 m

10. 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.

Ans. Since speed of sound in air = 344 m/s
and speed of sound in aluminium = 6420 m/s

we know that v = distance/time therefore time = d/v

time taken by sound wave in air/time taken by sound wave in aluminium

= d/344: d/6420 = 6420/344 = 18.66/1

the sound will take 18.66 times more time through air than in aluminium in reaching other boy.

EXERCISE-11.4
Frequently Asked Questions

1. The frequency of a source of sound is 100 Hz. How many times does it vibrate in a minute?

Ans. Frequency of source of sound being 100 Hz means the sound source vibrates 100 times in one second.

therefore vibrations made by sound source in 1 min 60 sec = 100×60 = 6000

2. Does sound follow the same laws of reflection as light does? Explain.

Ans. Yes. Sound follows the same laws of reflection as light does. We can say that because here the directions in which the sound is incident and is reflected make equal angles with the normal to the reflecting surface at the point of incidence, and the three are in the same plane.

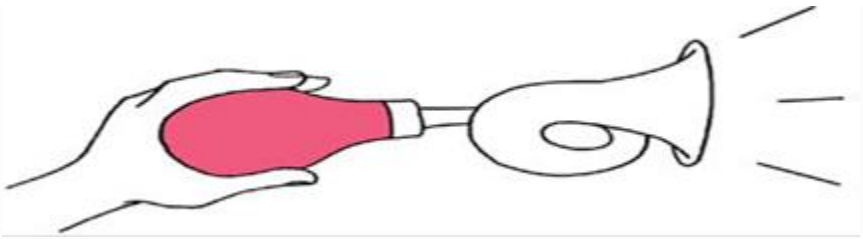
3. When a sound is reflected from a distant object, an echo is produced. Let the distance between the reflecting surface and the source of sound production remains the same. Do you hear echo sound on a hotter day?

Ans. As the sensation of sound persists in our brain for about 0.1 s.To hear a distinct echo the time interval between the original sound and the reflected one must be at least 0.1s. There for the total distance covered by the sound from the point of generation to the reflecting surface and back should be at least $(344\ m/s) \times 0.1\ s$ = 34.4 m. Thus, for hearing distinct echoes, the minimum distance of the obstacle from the source of sound must be half of this distance, that is, 17.2 m. Speed of sound will increase with increase in temperature. Therefore, on a hotter day speed of sound will be greater hence echoes may be heard more than once because of multiple reflections of sound result will be no distinct echo will be heard by us.

4. Give two practical applications of reflection of sound waves.

Ans. Two practical applications of reflection of sound waves

i. Megaphones or loudhailers, horns, musical instruments such as trumpets and shehanais, are all designed to send sound in a particular direction without spreading it in all directions.



ii. Stethoscope is a medical instrument used for listening to sounds produced within the body, chiefly in the heart or lungs. In stethoscopes the sound of the patient's heartbeat reaches the doctor's ears by multiple reflection of sound.

5. 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, $g = 10\ \text{m s}^{-2}$ and speed of sound = $340\ \text{m s}^{-1}$.

Ans. $v^2 = u^2 + 2gh$

$= 0 + 2\times10\times500 = 10000$

v = $\sqrt{10000}$ = 100 m/s

we also know that v = u + gt = 0 + 10t

100 = 10t or, Time taken by stone to reach the pond surface t = 100/10 = 10 sec

therefore, time taken by sound to reach the top from pond surface = d/v = 500/340

= 1.47 sec

so the total time taken for splash being heard at the top = 10 + 1.47 = 11.47 s

6. A sound waves travels at a speed of $339\ \text{m s}^{-1}$. If its wavelength is 1.5 cm, what is the frequency of the wave? Will it be audible?

Ans. Since we know that $v = \lambda\ \nu$

339 = 0.015 $m \times \nu$

ν = 339/0.015 = 22600 Hz

Since the resulting frequency is beyond the audible range of human beings 20Hz to 20kHz therefore sound will not be audible to human ears.

7. What is reverberation? How can it be reduced?

Ans. The repeated reflection of sound due to which sound persists for a long time is called reverberation.

To reduce reverberation, the roof and walls of the auditorium are generally covered with sound-absorbent materials like compressed fibreboard, rough plaster or draperies. The seat materials are also selected on the basis of their sound absorbing properties.

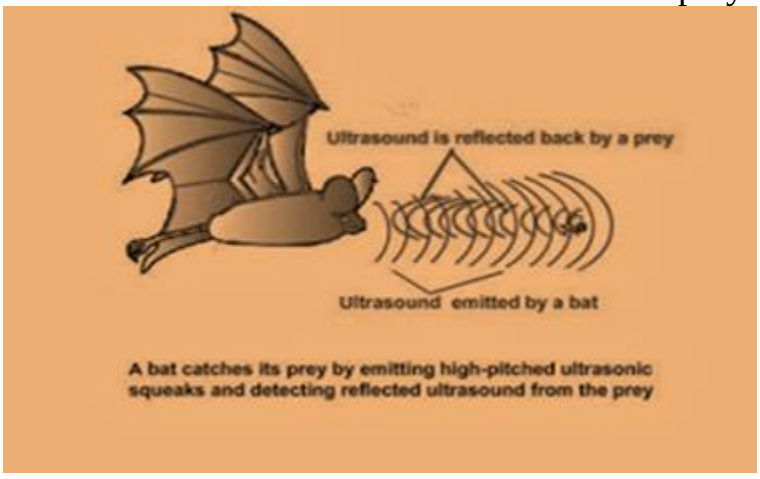
8. What is loudness of sound? What factors does it depend on?

Ans. Loudness is a measure of the response of the ear to the sound. Even when two sounds are of equal intensity, we may hear one as louder than the other simply because our ear detects it better.

Loudness of sound depends upon the amplitude of those sound waves. Higher is the amplitude of vibrating air particles louder will be the sound.

9. Explain how bats use ultrasound to catch a prey.

Ans. Bats search out prey and fly in dark night by emitting and detecting reflections of ultrasonic waves. The high-pitched ultrasonic squeaks of the bat are reflected from the obstacles or prey and returned to bat's ear. The nature of reflections tells the bat where the obstacle or prey is and what it is like.



10. How is ultrasound used for cleaning?

Ans. Ultrasound is generally used to clean parts located in hard-to-reach places, for example, spiral tube, odd shaped parts, electronic components etc. Objects to be cleaned are placed in a cleaning solution and ultrasonic waves are sent into the solution. Due to the high frequency, the particles of dust, grease and dirt get detached and drop out. The objects thus get thoroughly cleaned.

11. Explain the working and application of a sonar.

Ans. Sonar is a device that uses ultrasonic waves to measure the distance, direction and speed of underwater objects.

Sonar consists of a transmitter and a detector and is installed in a boat or a ship. The transmitter produces and transmits ultrasonic waves. These waves travel through water and after striking the object on the seabed, get reflected back and are sensed by the detector. The detector converts the ultrasonic waves into electrical signals which are appropriately interpreted. The distance of the object that reflected the sound wave can be calculated by knowing the speed of sound in water and the time interval between transmission and reception of the ultrasound. Let the time interval between transmission and reception of ultrasound signal be t and the speed of sound through seawater be v. The total distance, 2d travelled by the ultrasound is then, $2d = v \times t$.

The above method is called echo-ranging. The sonar technique is used to determine the depth of the sea and to locate underwater hills, valleys, submarine, icebergs, sunken ship etc.