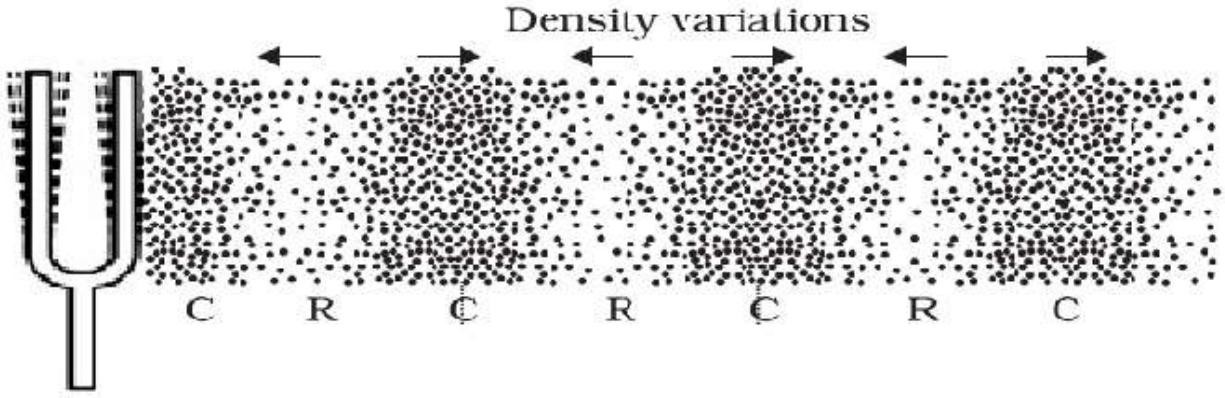
Sound: Exercise Questions

Q.1 What is sound and how is it produced?

Sol. Sound is a type of energy which produces the sensation of hearing. It is produced by the vibrations of objects. Example: ringing the bell.

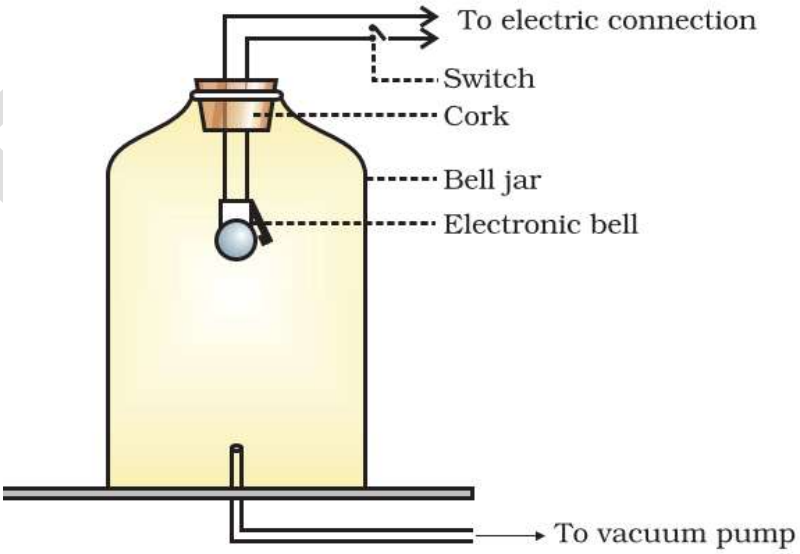
Q.2 Describe with the help of a diagram, how compressions and rarefactions are produced in air near a source of sound?

Sol. When an object vibrates, it alternately compresses and rarefies the neighborhood air. The compressed air has higher pressure and higher density than surrounding air. Therefore it pushes its near air particles and due to this compression moves forward. A rarefaction or low pressure is created at the original place. These compressions and rarefaction causes particles in the air to vibrate at their mean position. The energy is moved forward in these vibration. In this way, sound travels in a medium.



Q.3 Cite an experiment to show that sound needs a material medium for its propagation?

Sol. Sound waves are the mechanical waves so they need a material medium to travel. To prove this, take an electric bell and suspend it inside an air tight glass jar which is connected to a vacuum pump. Now switch ON the bell. You will be able to hear the bell ring. Now pump out the inside air from the glass jar. You will find that the sound of the bell will become fainter and after some time, the sound will not be heard. This happens because almost all air of glass jar has been pumped out. This activity shows that sound needs a material medium to travel.



Q.4 Why sound wave is called a longitudinal wave?

Sol. Sound wave is called longitudinal wave because when sound wave propagates then the air particles vibrates parallel to the direction of propagation and it produces compressions and rarefactions in the air.

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

Sol. The quality or timber of sound is the characteristic of the sound helps us to identify our friend by his voice.

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

Sol. Thunder is heard a few second after the flash of light is seen because light and sound both travel in different speed in air medium. Light travels at the speed of 3×10^8m/s whereas sound travels at approx. 330 m/s.

Q.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.

Sol. Given: range of hearing = 20 Hz to 20 kHz
Speed of sound in air = 344 m/s
As we know that
Speed = wavelength x frequency

So, wavelength = speed / frequency
$\lambda = v/n$
When frequency n1 = 20 Hz
Then wave length $\lambda1 = 344/20 = 17.2$ m

When frequency n2 = 20 kHz or 20000 Hz
Wavelength $\lambda2 = 344/20000 = 0.0172$ m
Therefore, the wavelength of the sound corresponding to 20 Hz to 20 kHz is 17.2 m and 0.0172m respectively.

Q.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.

Sol. Velocity of sound wave in air v1 = 346 m/s
Velocity of sound wave in aluminium v2 = 6420 m/s
Let length of rod be l.
Time taken by sound wave in air medium t_1 = l / velocity of sound in air
Time taken by sound wave in Aluminium rode t_2 = l / velocity of sound in Aluminium rode

Now, the ratio, t_1 / t_2 = velocity in Aluminium /velocity in air
= 6420 / 346
=18.55: 1

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

Sol. Given: frequency of sources of sound v=100Hz=100 vibration / sec

Time taken = 1 min. = 60s

As we know that frequency = No. of vibrations / time period

No. of vibrations = frequency x time period

No. of vibrations = 100 x 60 =6000 vibration

Q.10 Does sound follow the same laws of reflection as light does? Explain.

Sol. ***Yes,*** Sound follows the same laws of refection as light. When sound is reflected by hard surfaces:

(i) Incidence sound wave, reflected sound wave and normal all lie in the same plane.

(ii) Angle of incident of sound wave is equal to angle of reflected sound wave i.e. ∠ i = ∠ r

Q.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?

Sol. We can hear the echo when the time for the reflected sound is heard after 0.1 s.

Time taken=Total distance / velocity.

On a hotter day the velocity of sound is more. So, we can hear the echo sooner. If the time taken by echo is less than 0.1 s then it will not be heard.

Q.12 Give two practical applications of reflection of sound waves?

Sol. ***The t***wo practical applications of reflection of sound waves are -

(a) Megaphones or loud hailers are designed to send sound in a particular direction with help of reflection of sound.

(b) Stethoscope are based on the principle of reflection of sound within the stethoscope tube and enable the doctor to hear a patient's heartbeat.

Q.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 = 10m/s2 square and speed of sound = 340 m/s.

Sol. ***Given:*** Height of tower = 500 m

Acceleration due to gravity g = 10m/s²

Speed of sound = 340 m/s

Time for the stone to reach the water surface.

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

500 = 0 x t + ½ x 10 x t²

500/5 = t²

t = 10 s

Now, Time for sound of splash to reach the top

t'=Distance / Velocity = 500 / 340 = 1.47s

Therefore Total time = t + t' = 11.47s

So, in 11.47 s the splash will be heard on the top.

Q.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? Will it be audible?

Sol. Given: Velocity v = 339 m/s
Wavelength $\lambda = 1.5cm = 1.5 \times 10^{-2} m$
According to formula: $v = n\lambda$; where n = frequency
$n = v / \lambda = 339 / (1.5 \times 10^{-2}) = 22600 Hz$
this sound will not be audible because human range is up to 20,000 Hz only.

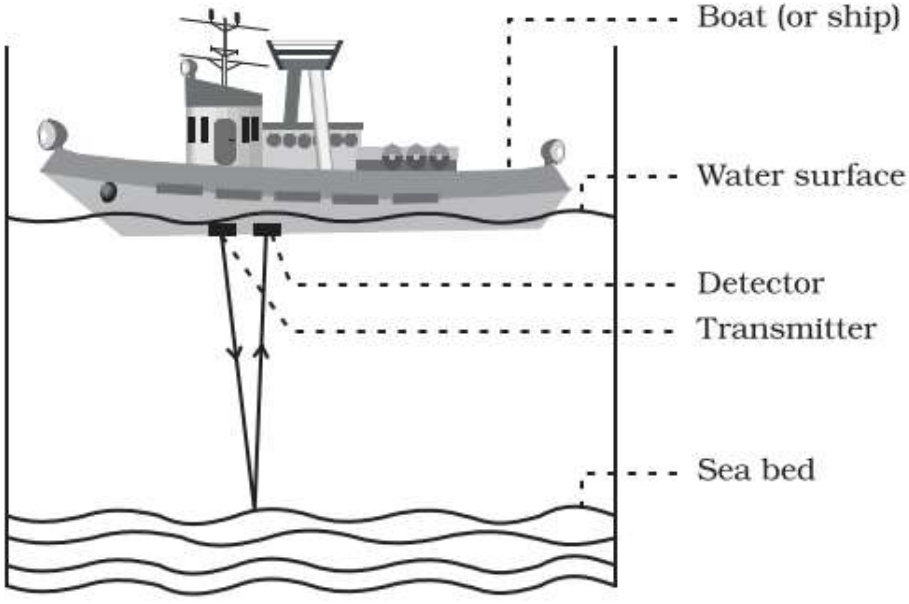
Q.15 What is reverberation? How can it be reduced?
Sol. The persistence of sound in the result of its repeated reflection is called reverberation. It can be reduced by covering walls and roof of auditorium by sound absorbent material like compressed fiberboard, rough plaster or draperies.

Q.16 What is loudness of sound? What factors does it depend on?
Sol. It is the physiological response of our ears to sound. It is determined by its amplitude and frequency and also age of the person. The range of hearing of sound for the human being is between 20 Hz to 20,000 Hz. Louder sound can travel a larger distance because higher energy is associated with it.

Q.17 Explain how bats use ultrasound to catch a prey?
Sol. Bat emits ultrasounds. These ultrasounds are reflected by various obstacles or prey and return to the bat's ear. After getting ultra sound, bat detects where obstacle or prey is and accordingly the bat is able to catch its prey.

Q.18 How is ultrasound used for cleaning?
Sol. Ultrasound waves are high frequency waves. It is used to clean the parts located in hard to reach places like- spiral tubes, electronic components. Objects need to be cleaned are placed in a cleaning solution and ultrasonic waves are sent into this solution. Because of high frequency vibration the dust, grime etc. are detached from the object.

Q.19 Explain the working and application of a sonar?
Sol. The SONAR stands for Sound, Navigation and Ranging device. It is used to measure distance, direction and speed of underwater objects. It has a transmitter and detector in ship or boat as shown in fig. The transmitter transmits ultrasonic waves which get reflected back by various underwater objects. These waves are received by the detector which converts these waves into required information.

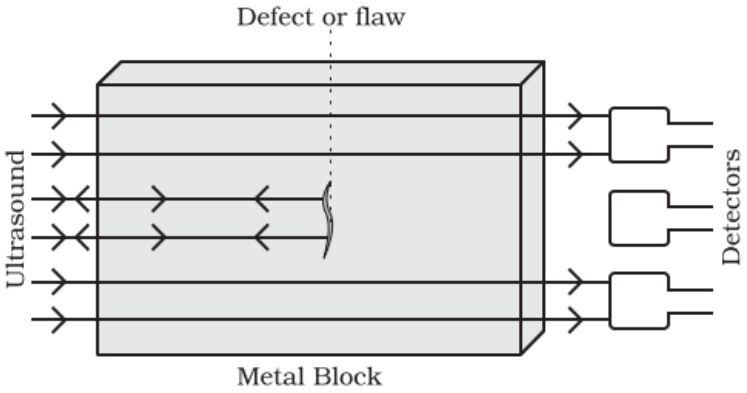


Q.20 A sonar device on a submarine sends out a signal and receives an echo 5 s later. Calculate the speed of sound in water if the distance of the object from the submarine is 3625 m.

Sol. Given: Time = 5 s (for echo to return)
Distance of object = 3625 m
The speed of sound in water:
$V = (2 \times d) / t = (2 \times 3625) / 5 = 1450 m/s$

Q.21 Explain how defects in a metal block can be detected using ultrasound?

Sol. Ultra sound is also used to detect cracks and flaws in metal blocks. Ultrasound wave is passed through the metal block which is to be tested. In case of cracks or flaws ultrasound does not pass through it and reflects back. A detector on the other side of the block is kept. If it does not receive all the transmitted waves, then the metal block has flaws.



Q.22 Explain how the human ear works?

Sol. The human ear has three parts: the outer ear, middle ear and inner ear.
Outer ear: It is also called 'pinna'. It collects the sound from the surrounding and passes through it auditory canal.
Middle ear: When the sound reaches to thin membrane called eardrum or tympanic membrane through the auditory canal. The sound waves vibrate this membrane and these vibrations are amplified by three small bones called hammer, anvil and stirrup.
Inner ear: Now, these vibrations reach the cochlea in the inner ear and are transformed into electrical signals which are passed to the brain through the auditory nerve, and the brain interprets these signals.