Chapter 12 – Sound

Class 9 Science NCERT Textbook – Page 162

Q1. How does the sound produced by a vibrating object in a medium reach your ear?

Answer: A vibrating object, vibrates the particles of the medium which applies force on other particles. So, the first particle of medium return to its original position and thus sound reaches our ear.

Class 9 Science NCERT Textbook – Page 163

Q1. Explain how sound is produced by your school bell?

Answer: Sound produced by the school bell is depends on the vibration of bell. When the bell moves forward, the air particles create a high-pressure region called compression and when it moves backward, a low-pressure region is created called rarefaction.

Q2. Why are sound waves called mechanical waves?

Answer: Sound waves are called mechanical waves as they need a medium to propagate, like air, water, silver etc.

Q3. Suppose you and your friend are on the moon. Will you be able to hear any sound. Will you be able to hear any sound produced by your friend?

Answer: The moon has no air around i.e., there is no medium and sound cannot travel through a vacuum, so we cannot hear the sound.

Class 9 Science NCERT Textbook – Page 166

Q.5 Which wave property determines (a) loudness, (b) pitch?

Answer:

(a) Loudness is measured by the amplitude of the sound wave and it depends on the force with which the object vibrates.

(b) Pitch of a sound is determined by its frequency.

Q.6 Guess which sound has a higher pitch: guitar or car horn?

Answer: The guitar has a higher pitch because the particle's vibration frequency is higher in guitar than a car horn.

Class 9 Science NCERT Textbook – Page 166

Q1. What is wavelength, frequency, time-period and amplitude of a sound wave?

Answer:

i) The minimum distance at which a sound wave repeats itself is called as wavelength.
ii) The number of sound waves or cycles produced per second is called as frequency of the sound wave.
iii) The time required for one complete sound wave or cycle is called time-period of the sound wave.
iv) The maximum displacement of the particles of the medium from their original position, when a sound wave passes through the medium, is called amplitude.

Q2. How are the wavelength and frequency of a sound wave related to its speed?

Answer: Wavelength and frequency are inter-related. The shorter the wavelength, the higher the frequency. The speed of a sound wave depends on density, elasticity and temperature of the medium.

Q3. Calculate the wavelength of a sound wave whose frequency is 220 Hz and speed is 440 m/s in a given medium.

Answer:

$$r = 220Hz$$

$$v = 440m/s$$

$$\text{As, } wavelength = \frac{v}{r}$$

$$\frac{440}{220} = 2\ m$$

Q4. 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? 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: frequency, n = 500Hz

Time period of the wave, $T = \frac{1}{n}$

$$= \frac{1}{500} = 0.002\ seconds$$

$$T = 2\ mins$$

Class 9 Science NCERT Textbook – Page 166

Q1. Distinguish between loudness and intensity of sound.

Answer:

S/No.	Loudness	Intensity
1.	It is sensations in the ears which help us to distinguish between a faint sound and a loud sound is called loudness of sound.	The average energy transferred by a sound wave / second / unit area is called intensity of sound.
2.	It is measured in decibel (db.).	It is measured in watts / square metre.
3.	It depends on the sensitivity of ears.	It does not depend on the sensitivity of ears.

Class 9 Science NCERT Textbook – Page 167

Q1. In which of the three media, air, water or iron, does sound travel the fastest at a particular Q temperature?

Answer: Sound travels fast in solids than in liquids and it is the slowest in gases. So, sound travels fastest in metal like iron**.**

Class 9 Science NCERT Textbook – Page 168

Q1. An echo is heard 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?

Answer:

Time taken by sound to travel from the source to the reflecting surface, and back to the source is 3 seconds. So, the time taken by sound will be half of this time, which is 1.5 seconds.

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

$$342 = \frac{Distance}{1.5}$$

$$Distance = 342 \times 1.5\ m$$

$$= 513\ m$$

Class 9 Science NCERT Textbook – Page 169

Q1. Why are the ceilings of concert halls curved?

Answer: The ceiling of concert halls is curved so that people seated at the back rows of the hall may not hear the sound from the speaker clearly. When the ceiling is curved or concave, it reflects sound waves to travel to distances.

Class 9 Science NCERT Textbook – Page 170

Q1. What is the audible range of the average human ear?

Answer: Humans can detect sounds in a frequency range from about 20 Hz to 20 kHz. Human infants can hear frequencies higher than 20 kHZ and average adults can hear up to 15–17 kHz.

Q2. What is the range of frequencies associated with?

(a) Infrasound?

(b) Ultrasound?

Answer:

a. Range of frequencies associated with infrasound: 1 Hz to 20 Hz.

b. Range of frequencies associated with Ultrasounds is more than 20 kHz or 2000 Hz.

Class 9 Science NCERT Textbook – Page 172

Q1. 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: Time taken, t = 1.02 s

Speed of sound, v = 1531 m/s

Distance of the cliff from the submarine = $speed\ of\ sound\ \times time\ taken$

Distance of the cliff from the submarine = 1.02 x 1531 = 1561.32 m

Distance travelled by the sonar pulse on its transmission and reception in water = 2 x Actual distance = 2d

Actual Distance, d= 1561/2

= 780.31 m

Class 9 Science NCERT Textbook – Page 174 and 175 (Exercise)

Q1. What is sound and how is it produced?

Answer:

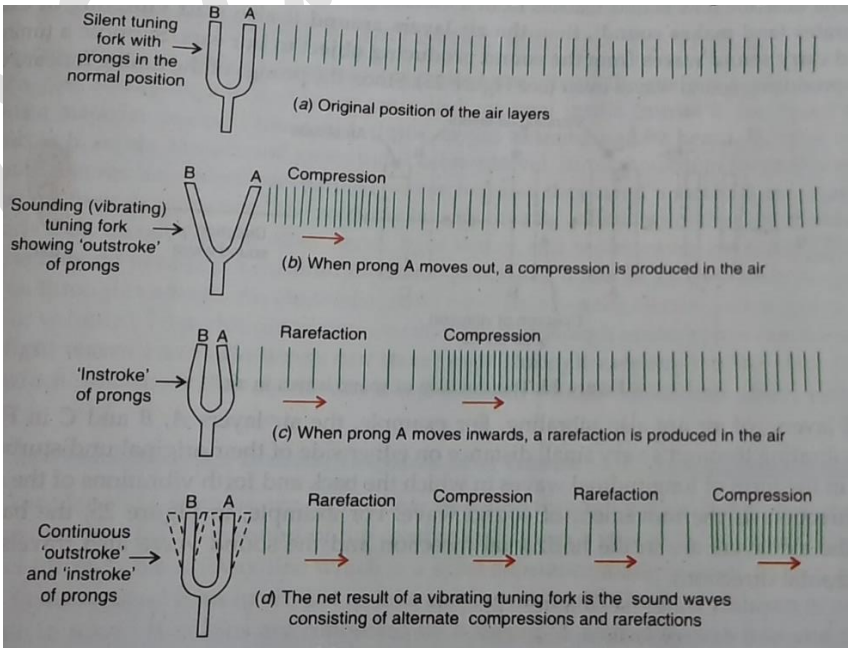
Sound is a form of energy to hear and is produced when objects vibrate.

For example, sound is produced by:

a) vibrating strings of a sitar.
b) vibrating air in flute.
c) vibrating drums
d) vibrating plates in cymbals.

Q2. Describe with the help of a diagram, how compression and rarefactions are produced in air near a source of sound.

Answer:



Production of sound waves in air

a) First figure (a) shows the original position of air, when no sound is passing through it.
b) If we strike a tuning fork on a rubber pad so that both the prongs start vibrating and produce sound.
c) Second figure (b) shows that when prong A moves to the right side, it pushes the layer of air which further pushes the next layer of air and the process goes on. So, the layer of air near prong A form a 'compression'. This compression pass on the next layers and move towards the right side .

(d) In third figure (c) prong A moves to the left side, it leaves a region of low pressure on the right side and layers of air move apart to form a 'rarefaction'. A rarefaction move to the right side.

(e) Fourth figure (d) show, a sound producing body have the waves with alternate compression and rarefaction in air,

Q3. Cite an experiment to show that sound needs a material medium for its propagation.

Answer:

A material medium, air help in the transmission of sound. Sound cannot travel through vacuum or empty space. To justify this:

1. If an electric bell is placed in airtight glass jar with air, it helps to hear sound of ringing bell. When air is a medium in the bell jar, sound travel through it and we hear sound.
2. If bell jar with ringing bell is placed on the plate of a vacuum pump and air is removed slowly from the bell jar. So, the sound of ringing bell faint. When the air is removed completely from the jar, there will be no sound. This shows that sound cannot travel through vacuum.
3. Sound can travel through solids, liquids and gases because the molecules of these matters carry the sound waves through their vibrations.

Q4. Why is sound wave called a longitudinal wave?

Answer:

The particles of the medium in a sound wave vibrate in the same direction of wave, so they are called a longitudinal wave.

Q5. Which characteristic of the sound helps you to identify your friend by his voice while sitting with others in a dark room?

Answer:

Quality of sound helps to identify a friend by his voice while sitting with others in a dark room

Q6. Flash and thunder are produced simultaneously. But thunder is heard a few seconds after the flash is seen. Why?

Answer:

Flash and thunder are produced simultaneously Due to the very high speed of light that the flash is seen first as compared to low speed of sound. So, the thunder is heard a few seconds later.

Q7. 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 ms^{-1}.

Answer:

a)

Speed, $v = 344\, m/s$

Frequency, $f = 20\, Hz$

Wavelength, $\lambda = ?$

$$v = f \times \lambda$$

$$344 = 20 \times \lambda$$

$$\lambda = \frac{344}{20}\, m$$

Wavelength, $\lambda = 17.2\, m$

b)

Speed, $v = 344\, m/s$

Frequency, $f = 20\, kHz$

$$= 20 \times 1000\, Hz$$

$$= 20000\, Hz$$

Wavelength, $\lambda = ?$

$$v = f \times \lambda$$

$$344 = 20000 \times \lambda$$

$$\lambda = \frac{344}{20000}$$

Wavelength, $\lambda = 0.0172\, m$

So, the wavelengths of sound in air have frequency of 20 Hz is 17.2 m

and 20 kHz is 0.0172 m.

Q8. Two children are at opposite ends of an aluminium rod. One strikes the end of rod with a stone. Find the ratio of times by sound wave in air and in aluminium to reach the second child (Given: Speed of sound in air = 346 m/s; Speed of sound in aluminium = 6420 m/s).

Answer:

If the length of aluminium rod is l. The distance travelled by sound in aluminium and in air to reach the second child is equal to l.

i) $$Speed\ of\ sound\ (in\ air) = \frac{Distance\ travelled\ in\ air}{Time\ taken\ in\ air}$$

$$346 = \frac{l}{Time\ taken\ in\ air}$$

$$Time\ taken\ in\ air = \frac{l}{Time\ taken\ in\ air}$$

ii) $$Speed\ of\ sound\ in\ aluminium = \frac{Distance\ travelled\ in\ aluminium}{Time\ taken\ in\ aluminium}$$

$$6420 = \frac{l}{Time\ taken\ in\ aluminium}$$

$$Time\ taken\ in\ aluminium = \frac{l}{6420}$$

The ratio of time taken by sound in air and in aluminium:

$$\frac{Time\ taken\ by\ sound\ in\ air}{Time\ taken\ by\ sound\ in\ aluminium} = \frac{l}{346} \times \frac{6420}{l}$$

On cancelling:

$$\frac{Time\ taken\ by\ sound\ in\ air}{Time\ taken\ by\ sound\ in\ aluminium} = \frac{6420}{346}$$

$$= \frac{18.55}{1}$$

So, the ratio of time taken by the second wave in air and aluminium to reach the second child is 18.55:1.

Q9. The frequency of a source of sound is 100 Hz. How many times does it vibrate in a minute?

Answer:

The frequency of a source of 100 Hz i.e., the source of sound vibrates 100 times in one second.

As, 1 minutes = 60 seconds.

Number of vibrations in 1 second $= 100$

Number of vibrations in 60 seconds $= 100 \times 60$

$= 6000$ times

So, the source of sound vibrates 6000 times per minute.

Q10. Does sound follow the same laws of reflection as light does? Explain.

Answer:

Sound is reflected in same way as light. For example;

i) The incident sound wave, the reflected wave, and the normal at the point of incidence lie in the same plane.
ii) The angle of reflection of sound is always equal to the angle of incidence of sound.

Q11. 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 remain the same. Do you hear echo sound on a hotter day?

Answer:

The speed of sound increases on a hotter day and echo is heard at a larger distance from the reflecting surface. The distance between the reflecting surface and the source of sound is same, so no echo is heard on a hotter day.

Q12. Give two practical application of reflection of sound waves.

Answer: Reflection of sound wave is used in:

i) the working of megaphone.

ii) the working of a stethoscope.

Q13. A stone is dropped from the top of a tower 500 m high into a pond of water at the base of the tower. What is the splash heard at the top? Given: $g = 10\ ms^{-2}$ and speed of sound $= 340\ ms^{-1}$.

Answer:

Distance covered , $s = 500\ m$

Initial speed, $u = 0$

Acceleration, $g = 10\ ms^{-2}$

Time taken, $t =$?

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

$$500 = 0\ \times t + \frac{1}{2} \times 10\ \times\ t^2$$

$$500 = 5\ \times\ t^2$$

$$t^2 = \frac{500}{5}$$

$$t^2 = 100$$

$$t = \sqrt{100}$$

$$t = 10\ sec$$

So, the stone takes 10 sec to fall into water and produces the sound of splash which travels a distance of 500 m to be heard at the top of the tower.

$$Speed\ of\ sound = \frac{Distance\ travelled\ by\ sound}{Time\ taken\ by\ sound}$$

$$340 = \frac{500}{Time\ taken\ by\ sound}$$

$$Time\ taken\ bu\ sound = \frac{500}{340}\ sec$$

$$= 1.47\ sec$$

The time at which splash is heard from the top of tower $= 10\,\text{sec} + 1.47\ sec = 11.47\ sec$

Q14. A sound travels at a speed of $399\ ms^{-1}$. If its wavelength is $1.5\ cm$, what is the frequency of the wave? Will it be audible?

Answer:

Speed of sound, $v = 339\ ms^{-1}$

Frequency, $f = ?$

Wavelength, $\lambda = 1.5\ cm$

$$= \frac{1.5}{100}\ m$$

$$= 0.015\ m$$

$$v = f \times \lambda$$

$$339 = f \times 0.015$$

$$f = \frac{339}{0.015}$$

Frequency, $f = 22600\ Hz$

The frequency of 22600 Hz of sound wave is more than upper limit of hearing that is 20000 Hz, so, sound will not be audible. It is called ultrasonic sound.

Q15. What is reverberation? How can it be replaced?

Answer:

The resolution of sound in a big hall due to reflection from the walls, ceiling and floor of the hall is called reverberation. If the reverberation is too long, the sound is blurred due to overlapping of different sounds.

The methods to reduce reverberation in big hall and auditorium are:

i) Panels of sound-absorbing materials are put on the walls and ceiling of big halls and auditorium to reduce reverberations.
ii) Floors are covered with carpets to absorb sound and reduce reverberations.
iii) Heavy curtains are put on doors and windows to absorb and reduce reverberations.

Q16. What is loudness of sound? What factors does it depend on?

Answer:

Loudness of sound depends on the sensation in the ears to distinguished between a faint and a loud sound. It depends on the amplitude of sound waves which is equal to that of vibrations. It also depends on the force with which it vibrates .

Q17. Explain how bat use ultrasound to catch a prey?

Answer:

The high frequency ultrasound are emitted by bats when flying and listen to the echoes produced by the prey like a flying insect. The time taken by the echo is heard by bats and judge the distance of the insect and catch it.

Q18. How is ultrasound used for cleaning?

Answer:

Ultrasound is used in industry to clean spiral tubes, odd-shaped machines and electronic components etc. The objects are placed in the cleaning solution and then the ultrasound is passed into the solution. The ultrasound waves due to their high frequencies, stir the cleaning solution, as the particles of dust and grease on dirty object vibrate, get loose and mix with solution.

Q19. Explain the working and application of a sonar.

Answer:

Sonar is a device used to find the depth of a sea or to locate the under-water things like fish, shipwrecks, and enemy submarines.

Sonar works by sending a ultrasonic sound from a ship into sea-water and the echo produced by the reflection of ultrasonic sound from under-water objects is heard. Time taken for the echo is measured by the sonar transmitter and receiver.

Then the distance of the under-water object is measured from the time taken by the echo to return.

Applications of Sonar: It is used in

1. ships and submarines for underwater communications.
2. medical science for detecting cysts and cancer cells known as sonogram.
3. detection of enemy vessels and torpedo by military.
4. inspecting damages in pipelines used for oil and gas.

Q20. A sonar device on a submarine sends out a signal and receives an echo 5 sec later. Calculate the speed of sound in water if the distance of the distance of the object from the submarine is 3625 m.

Answer:

Time taken by ultrasonic signal from sonar to travel from submarine to the object and back = 5 sec

Time taken by ultrasonic to travel from submarine to the object = 2.5 sec

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

$$Speed = \frac{3625\ m}{2.5\ sec}$$

$$Speed = 1450\ m/s$$

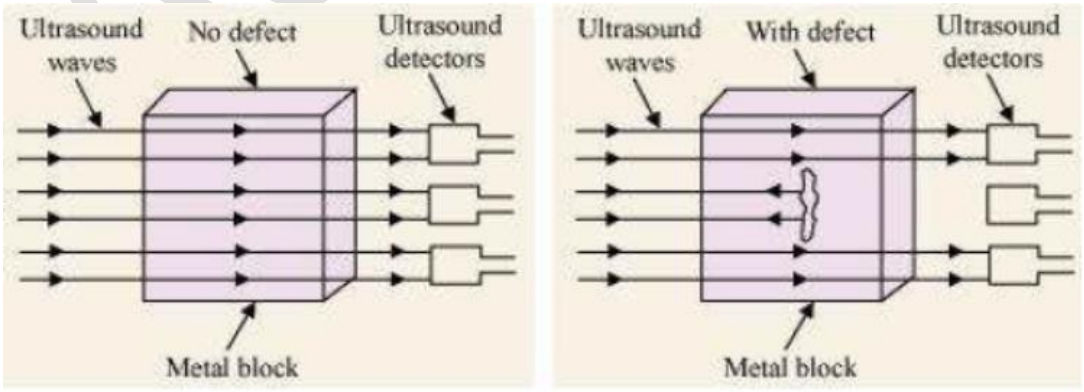
So, the speed of sound in sea water is 1450 m/s.

Q21. Explain how defects in a metal block can be detected using ultrasound.

Answer:

Ultrasound waves are made to pass through one side of the metal block, and ultrasound detectors are placed on the opposite side of metal block to detect the transmitted ultrasound waves.

a) If the ultrasound waves pass through various part of the metal block, then the metal block is defect-free with no internal cracks.
b) If ultrasound waves are not able to pass through a part of the metal block and get reflected back, so there is a defect in the metal block.



a) No ultrasound reflected.
b) Ultrasound reflected from a part of block.

Q22. Explain how the human ear works.

Answer:

1. The sound waves are collected in the pinna of outer ear.
2. Sound waves pass through ear canal and then on the ear-drum.
3. Sound waves consists of compressions which strikes the ear-drum, so the pressure increases and move the ear-drum inwards.
4. When rarefaction of sound wave falls on the ear-drum, the pressure decreases and it moves ear - drum outward.
5. So, the ear-drum starts vibrating.
6. The vibrating ear-drum causes vibrating a small bone hammer and are passed to the second bone and then to the third bone.
7. This strike to membrane of the oval window and passes its vibrations to the liquid in the cochlea which start vibrating.
8. Vibrating liquid of cochlea give electrical impulses in the nerve cells which are carried by auditory nerve to the brain.
9. The brain interprets electrical impulses as sound and give a sensation of hearing.