SOUND

NCERT EXERCISE AND SOLUTIONS - SCIENCE

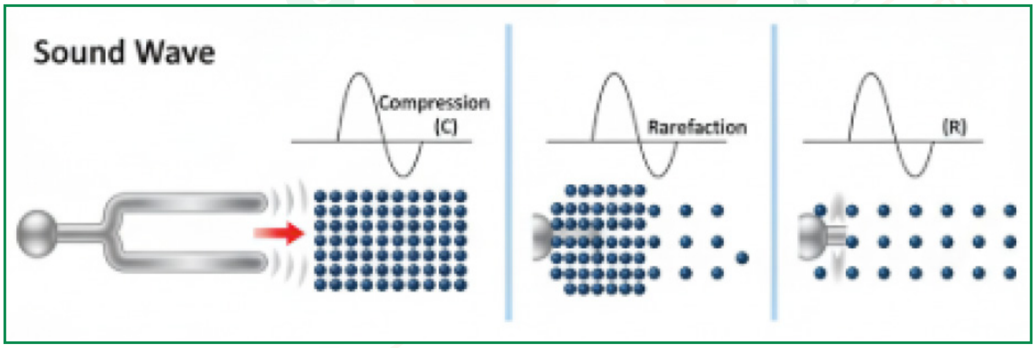
Q. 1. What is sound and how is it produced?

ANSWER:-

Sound is a type of energy that we hear because of vibrations. When something vibrates, it makes the particles around it shake too, and those particles cause nearby ones to shake as well. This movement creates a wave in the air or other materials. When these waves reach our ears, we hear the sound.

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

ANSWER:-



Sound travels most commonly through air. When an object vibrates, it pushes the air in front of it, creating an area of high pressure called compression (C). This compression moves away from the vibrating object. When the object moves back, it creates an area of low pressure called rarefaction (R). As the object moves quickly back and forth, it creates a series of compressions and rarefactions that travel through the air, making up the sound wave.

Compression is the high-pressure area, and rarefaction is the low-pressure area. The pressure is related to how many particles are in a given space. More particles in the medium result in higher pressure, and fewer particles lead to lower pressure. So, sound waves can be seen as pressure or density changes moving through the medium.

Q. 3. Why is sound wave called a longitudinal wave?

ANSWER:-

A sound wave is called a longitudinal wave because the particles in the medium move back and forth in the same direction as the wave is traveling. Instead of moving to different locations, the particles simply vibrate around their resting position. This back-and-forth motion is what makes sound a longitudinal wave.

Q. 4. Which characteristic of the sound helps you to identify your friend by his voice while sitting with others in a dark room?

ANSWER:-

The characteristic of sound that allows you to recognize your friend's voice, even when you're in a dark room with others, is called the quality or timbre of sound. This quality helps us tell different sounds apart, even if they have the same pitch and loudness.

Q. 5. Flash and thunder are produced simultaneously. But thunder is heard a few seconds after the flash is seen, why?

ANSWER:-

Velocity of sound is 344 m/s and that of light is 3×10^{1} m/s. As the speed of light is greater than that of sound, the sound of thunder requires longer time than light to reach Earth. Therefore, before we hear thunder, a flash is seen.

Q. 6. 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}.

ANSWER:-

In the above question it is given that:

A person has a hearing range from 20 Hz to 20 kHz. Speed of sound in air is 344 m/s. We know that:

Speed = Wavelength Frequency

$$\therefore v = \lambda \times v$$

For, $v^2 = 20Hz$

$$\therefore \lambda_1 = \frac{v}{u_1} = \frac{344}{20} = 17.2m$$

For, $v_2 = 20kHz$

$$\therefore \lambda_2 = \frac{v}{v_2} = \frac{344}{20000} = 0.0172m$$

Hence, humans have the wavelength range for hearing from 0.0172 m to 17.2 m.

Q. 7. 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.

ANSWER:-

Consider the length of the aluminium rod to bed.
Speed of sound waves in aluminium at 25°C is $v_{\mu\mu}$ = 6420 m/s.
Speed of sound waves in air at 25°C is v_{Az} = 346 m/s.
Therefore, the time taken by a sound wave to reach the other end will be:

$$t_{sir} = \frac{d}{v_{rar}} = \frac{d}{346}$$

Hence, the ratio of time taken by the sound wave in air and aluminium will be:

$$\frac{t_{sit}}{t_{si}} = \frac{\frac{d}{346}}{\frac{d}{6420}} = \frac{6420}{346} = 18.55$$

Q. 8. The frequency of a source of sound is 100 Hz. How many times does it vibrate in a minute?

ANSWER:-

In the above question it is given that:
Frequency of sound is 100 Hz.
Total time = 1 min = 60 s.
We know that: Frequency is defined as the number of oscillations per second. It is given by the relation:
Number of oscillations Frequency × Total time
Number of oscillation =100×60=6000
Hence, the source vibrates 6000 times in a minute, producing a frequency of 100 Hz.

Q. 9. Does sound follow the same laws of reflection as light does? Explain.

ANSWER:-

Reflection of Sound: When a sound wave hits a surface, the angle at which the sound wave strikes the surface (incident angle) is the same as the angle at which it bounces off (reflected angle). Both the incident and reflected sound waves, along with the normal (an imaginary line perpendicular to the surface), all lie in the same plane. This means that sound follows the same laws of reflection as light.

Q. 10. 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?

ANSWER:-

Echo and Temperature: An echo is heard when there is a time gap of at least 0.1 seconds between the original sound and its reflection. The speed of sound in a medium depends on the temperature—sound travels faster in warmer conditions. So, when the temperature is higher, the time gap between the original sound and its reflection becomes shorter.

Q. 11. Give two practical applications of reflection of sound waves.

ANSWER:-

Practical Applications of Sound Reflection:

1. **SONAR:** SONAR technology uses sound reflection to measure the distance and speed of objects underwater.
2. **Stethoscope:** A stethoscope works by using the reflection of sound waves to carry the sound of a patient's heartbeat to the doctor's ear.

Q. 12. 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 ms^{-2} and speed of sound = 340ms^{-1}.

ANSWER:-

In the above question it is given that:
Height of the tower is s = 500 m.
Velocity of sound is v = 340 m/s.
Acceleration due to gravity is g = 10 m/s^2.
As the stone is initially at rest, initial velocity of the stone will be u = 0 m/s.
Let the time taken by the stone to fall to the base of the tower be t_1
According to the second equation of motion:

$$s = ut_1 + \frac{1}{2}gt_1^2$$

$$\Rightarrow 500 = \frac{1}{2}(10)(t_1)^2$$

$$\Rightarrow (t_1)^2 = 100$$

$$\Rightarrow t_1 = 10s.$$

Now, time taken by the sound to reach the top from the base of the tower will be

$$\Rightarrow t_2 = \frac{500}{340} = 1.47s$$

Hence, the splash is heard at the top after time t = t_2+t_2 = 10+1.47 = 11.47 s.

Q. 13. A sound wave travels at a speed of 339 ms^{-1}. If its wavelength is 1.5 cm, what is the frequency of the wave? Will it be audible?

ANSWER:-

In the above question it is given that:
Speed of sound is 339 m/s.

Wavelength of sound is $\lambda = 1.5$ cm = 0.015 m.
We know that: Speed of sound = Wavelength × Frequency

$$\Rightarrow v = \lambda \times \nu$$

Therefore frequency will be:

$$\Rightarrow \nu = \frac{v}{\lambda} = \frac{339}{0.015} = 22600 \text{ Hz}$$

As the frequency range of audible sound for humans lies between 20 Hz to 20,000 Hz. Since the frequency of the given sound is more than 20,000 Hz, it won't be audible.

Q. 14. What is reverberation? How can it be reduced?

ANSWER:-

Reverberation: Reverberation is the persistence of sound after the source has stopped producing it, caused by repeated reflections of the sound off walls and surfaces. In a large hall, the sound continues to bounce around until it fades away and becomes inaudible. To reduce reverberation, materials like compressed fiberboard, rough plaster, or draperies are used on the walls and ceiling, as they absorb sound. The choice of materials for seats is also based on their ability to absorb sound.

Ultrasound in Metal Inspection: Metals are commonly used in the construction of buildings, bridges, machinery, and scientific equipment. Ultrasound is used to detect cracks or flaws inside metal structures that may not be visible on the surface. These cracks weaken the structure, so ultrasonic waves are sent through the metal, and detectors pick up the waves that pass through, revealing any internal defects.

Q. 15. What is loudness of sound? What factors does it depend on?

ANSWER:-

Loudness is the subjective perception of how strong or loud a sound is, which allows a listener to rank a sound from quiet to loud. It is measured in a non-SI unit called the phon, but is most commonly quantified by the intensity level using the decibel (dB) scale. Loudness primarily depends on the amplitude (or intensity) of the sound wave: greater amplitude means more energy and a louder sound. However, it also critically depends on the frequency of the sound, as the human ear is most sensitive to sounds in the mid-range (around 1 kHz to 5 kHz), meaning a sound at a very low or very high frequency must have a much greater physical intensity to be perceived as equally loud. Lastly, loudness is affected by the distance from the source (decreasing rapidly as distance increases) and the duration of the sound.

Q. 16. How is ultrasound used for cleaning?

ANSWER:-

Ultrasound for Cleaning: Ultrasound waves are used for cleaning by passing through objects placed in a cleaning solution. Their high frequency helps remove dirt and debris from the surfaces of the objects.

Q. 17. Explain how defects in a metal block can be detected using ultrasound.

ANSWER:-

Loudness of Sound: Loudness refers to how we perceive the intensity of sound. It is determined by the amplitude of sound waves, which is related to the force used to make an object vibrate. A louder sound has a higher amplitude and more energy. Loudness increases with the square of the amplitude, meaning that larger vibrations result in louder sounds.