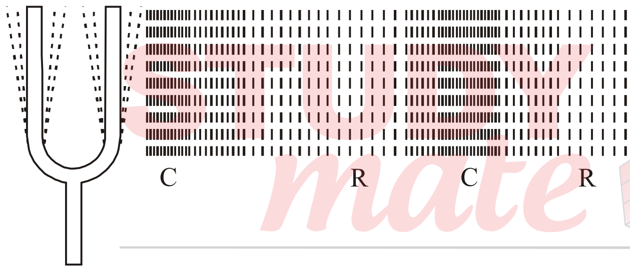
NCERT TEXTUAL EXERCISE (SOLVED)

1. What is sound and how is it produced?

Ans. Sound is produced by vibration. When a body vibrates, it forces the neighbouring particles of the medium to vibrate. This creates a disturbance in the medium, which travels in the form of waves. This disturbance, when reaches the ear, produces sound.

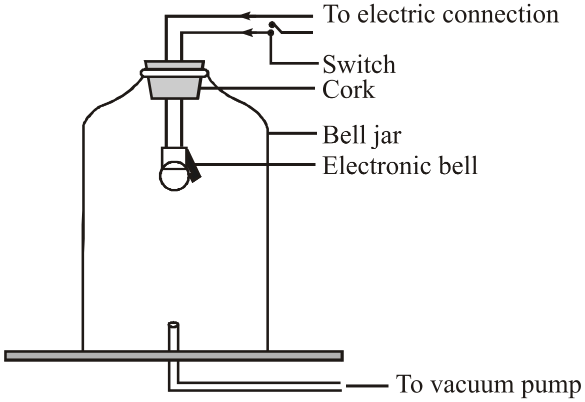
2. Describe with the help of a diagram, how compressions and rarefactions are produced in air near a source of sound.

Ans. When a vibrating body moves forward, it creates a region of high pressure in its vicinity. This region of high pressure is known as compressions. When it moves backward, it creates a region of low pressure in its vicinity. This region is known as a rarefaction. As the body continues to move forward and backwards, it produces a series of compressions and rarefactions (as shown in the following figure).



3. Give an experiment to show that sound needs a material medium for its propagation.

Ans. Take an electric bell and hang this bell inside an empty bell jar fitted with a vacuum pump (as shown in the following figure).



Initially, one can hear the sound of the ringing bell. Now, pump out some air from the bell jar using the vacuum pump. It will be observed that the sound of the ringing bell decreases. If one keeps on pumping the air out of the bell jar, then at one point, the glass jar will be devoid of any air. At this moment, no sound can be heard from the ringing bell, although one can see that the prong of the bell is still vibrating. When there is no air present inside, we can say that a vacuum is produced. Sound cannot travel through vacuum. This shows that sound needs a material medium for its propagation.

4. Why is sound wave called a longitudinal wave?

Ans. The vibration of the medium that travels along or parallel to the direction of the wave is called a longitudinal wave. In a sound wave, the particles of the medium vibrate in the direction parallel to the direction of the propagation of disturbance. Hence, a sound wave is called a longitudinal wave.

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

Ans. Quality of sound is that characteristic which helps us identify a particular person. Sound produced by two persons may have the same pitch and loudness, but the quality of the two sounds will be different.

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

Ans. The speed of sound (344 m/s) is less than the speed of light (3 × 108 m/s). Sound of thunder takes more time to reach the Earth as compared to light. Hence, a flash is seen before we hear a thunder.

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.

Ans. For a sound wave,

Speed = Wavelength × Frequency

$v = \lambda \times \nu$

Given that the speed of sound in air = 344 m/s

(i) For, $v = 20$ Hz

$$\lambda_1 = \frac{v}{v_1} = \frac{344}{20} = 17.2 \text{ m}$$

(ii) For, $v_2 = 20{,}000$ Hz

$$\lambda_2 = \frac{v}{v_2} = \frac{344}{20{,}000} = 0.0172 \text{ m}$$

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

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.

Ans. Let the length of the aluminium rod be d.

Speed of sound wave in aluminium at 25°C, v_{Al} = 6420 m/s

Therefore, time taken by the sound wave to reach the other end,

$$t_{Al} = \frac{d}{v_{Al}} = \frac{d}{6420}$$

Speed of sound wave in air at 25°C, v_{Air} = 346 m/s

Therefore, time taken by sound wave to reach the other end,

$$t_{Air} = \frac{d}{v_{Air}} = \frac{d}{346}$$

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

$$\frac{t_{Air}}{t_{Al}} = \frac{\frac{d}{346}}{\frac{d}{6420}} = \frac{6420}{346} = 18.55$$

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

Ans. Frequency is defined as the number of oscillations per second. It is given by the relation

$$\text{Frequency} = \frac{\text{Number of oscillations}}{\text{Total time}}$$

Number of oscillations = Frequency × Total time

Given, Frequency of sound = 100 Hz

Total time = 1 min = 60 s

Number of oscillations/vibrations = 100 × 60 = 6000

Hence, the source vibrates 6000 times in a minute, producing a frequency of 100 Hz.

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

Ans. Sound follows the same laws of reflection as light does. The incident sound wave and the reflected sound wave make the same angle with the normal to the surface at the point of incidence. Also, the incident sound wave, the reflected sound wave and the normal to the point of incidence all lie in the same plane.

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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?

Ans. An echo is heard when the time interval between the original sound and the reflected sound is at least 0.1 s. The speed of sound in a medium increases with an increase in temperature. Hence, on a hotter day, the time interval between the original sound and the reflected sound will decrease. Therefore, an echo can be heard only if the time interval between the original sound and the reflected sound is greater than 0.1 s.

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

Ans. (i) Reflection of sound is used to measure the distance and speed of underwater objects. This method is known as SONAR.

(ii) Working of a stethoscope is also based on reflection of sound. In a stethoscope, the sound of the patient's heartbeat reaches the doctor's ear by multiple reflection of sound.

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, $g = 10$ m/s^2 and speed of sound = 340 m/s.

Ans. Height of the tower, s = 500 m

Velocity of sound, $v = 340$ m/s

Acceleration due to gravity, $g = 10$ m/s^2

Initial velocity of the stone, $u = 0$ (since the stone is initially at rest)

Time taken by the stone to fall to the base of the tower, t_1

According to the second equation of motion:

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

$$500 = 0 \times t_1 + \frac{1}{2} \times 10 \times t_1^2$$

$$t_1^2 = 100$$

$$t_1 = 10\text{s}$$

Now, time taken by the sound to reach the top from the base of the tower, t_2

$$= \frac{500}{340} = 1.47 \text{ s.}$$

Therefore, the splash is heard at the top after time, t

Where $t = t_1 + t_2 = 10 + 1.47 = 11.47$ s

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?

Ans. Speed of sound, v = 339 m/s

Wavelength of sound, l = 1.5 cm = 0.015 m

Speed of sound = Wavelength × Frequency

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

$$\therefore \quad \nu = \frac{v}{\lambda} = \frac{339}{0.015} = 22{,}600 \text{ Hz}$$

The frequency range of audible sound for humans lies between 20 Hz and 20,000 Hz. Since the frequency of the given sound is more than 20,000 Hz, it is not audible.

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

Ans. Persistence of sound (after the source stops producing sound) due to repeated reflection is known as reverberation. As the source produces sound, it starts travelling in all directions. Once it reaches the wall of a room, it is partly reflected back from the wall. This reflected sound reaches the other wall and again gets reflected partly. Due to this, sound can be heard even after the source has ceased to produce sound.

To reduce reverberations, sound must be absorbed as it reaches the walls and the ceiling of a room. Sound absorbing materials like fibreboard, rough plastic, heavy curtains and cushioned seats can be used to reduce reverberation.

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

Ans. A loud sound has high energy. Loudness depends on the amplitude of vibrations. In fact, loudness is proportional to the square of the amplitude of vibrations.

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

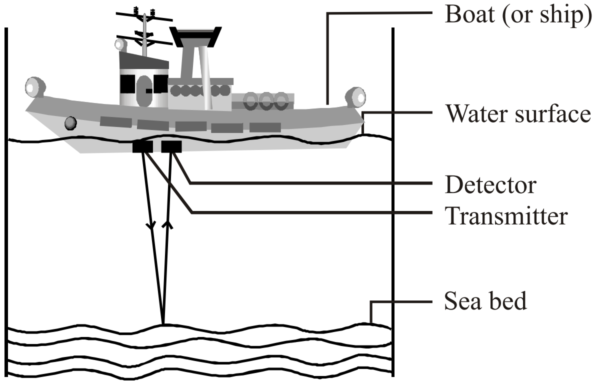
Ans. Bats produce high-pitched ultrasonic squeaks. These high-pitched squeaks are reflected by objects such as preys and returned to the bat's ear. This allows a bat to know the distance of his prey.

18. How is ultrasound used for cleaning?

Ans. Objects to be cleansed are put in a cleaning solution and ultrasonic sound waves are passed through that solution. The high frequency of these ultrasound waves detaches the dirt from the objects.

19. Explain the working and application of a sonar.

Ans. SONAR is an acronym for Sound Navigation And Ranging. It is an acoustic device used to measure the depth, direction, and speed of under-water objects such as submarines and ship wrecks with the help of ultrasounds. It is also used to measure the depth of seas and oceans.



A beam of ultrasonic sound is produced and transmitted by the transducer (it is a device that produces ultrasonic sound) of the SONAR, which travels through sea water. The echo produced by the reflection of this ultrasonic sound is detected and recorded by the detector, which is converted into electrical signals. The distance (d) of the under-water object is calculated from the time (t) taken by the echo to return with speed (v) and is given by $2d = v \times t$. This method of measuring distance is also known as 'echo-ranging'.

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.

Ans. Time taken to hear the echo, $t = 5$ s

Distance of the object from the submarine, $d = 3625$ m

Total distance travelled by the sonar waves during the transmission and reception in water = $2d$

Velocity of sound in water, $v = \frac{2d}{t} = \frac{2 \times 3625}{5} = 1450 \text{ m/s}^2$

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

Ans. Defects in metal blocks do not allow ultrasound to pass through them and they are reflected back. This fact is used to detect defects in metal blocks. Ultrasound is passed through one end of a metal block and detectors are placed on the other end. The defective part of the metal block does not allow ultrasound to pass through it. As a result, it will not be detected by the

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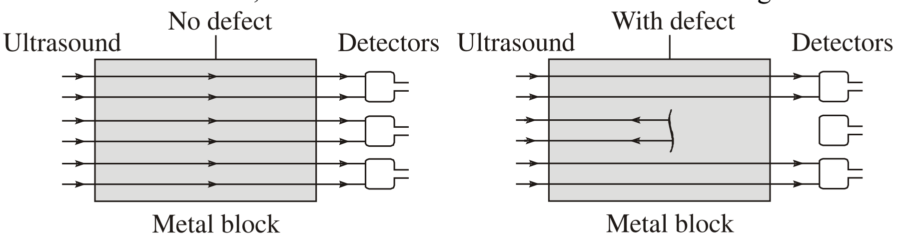
detector. Hence, defects in metal blocks can be detected using ultrasound.



22. Explain how the human ear works.

Ans. Different sounds produced in our surroundings are collected by pinna that sends these sounds to the ear drum via the ear canal. The ear drum starts vibrating back and forth rapidly when the sound waves fall on it. The vibrating eardrum sets the small bone hammer into vibration. The vibrations are passed from the hammer to the second bone anvil, and finally to the third bone stirrup. The vibrating stirrup strikes on the membrane of the oval window and passes its vibration to the liquid in the cochlea. This produces electrical impulses in nerve cells. The auditory nerve carries these electrical impulses to the brain. These electrical impulses are interpreted by the brain as sound and we get a sensation of hearing.