Sound

CHAPTER 11

NCERT FOCUS

ANSWERS

Topic 1

1. When a disturbance is created on an object, it starts vibrating and sets the particles of the medium to vibrate. The particle of the medium is displaced from its mean position and exerts a force on the adjacent particle. As a result, the adjacent particle is disturbed from its mean position and the original particle comes back to rest. This process continues till the disturbance reaches our ear.

2. When the school bell is struck with a hammer, it starts vibrating and as a result of these vibrations, sound waves are produced.

3. Waves which need a material medium for propagation are called mechanical waves. Since sound waves also need a material medium for propagation, these waves are called mechanical waves.

4. No, we will not be able to hear the sound because sound requires a medium for its propagation. On the moon there is no atmosphere, *i.e.*, there is vacuum.

5. **(a)** Loudness is determined by the amplitude of the sound wave which in turn depends on the force with which the object is made to vibrate.

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

6. A guitar has a higher pitch than a car horn, provided the guitar is properly tuned.

7. Wavelength : The distance between two consecutive compressions (C) or two consecutive rarefactions (R) is called the wavelength, unit-metre.

Frequency : The number of oscillations per unit time is called frequency, unit-hertz.

Time period : The time taken by two consecutive compressions or rarefactions to cross a fixed point is called the time period, unit-second.

Amplitude : The magnitude of the maximum disturbance in the medium on either side of the mean value is called the amplitude of the wave, unit-metre.

8. The speed is defined as the distance travelled by a wave per unit time.

$$\text{Speed} = \frac{\text{distance}}{\text{time}} = \frac{\lambda}{T}$$

λ is the wavelength, T is time period.

$$\upsilon = \frac{1}{T} \quad \therefore v = \upsilon\lambda$$

$\therefore$ Speed = wavelength × frequency

9. Here, frequency of the sound wave, υ = 220 Hz

speed of the sound wave, v = 440 m s^{-1}

As $v = \upsilon\lambda, \lambda = \frac{v}{\upsilon} = \frac{440}{220} = 2\,\text{m}$

10. Here, frequency of the source, υ = 500 Hz; time period of the tone, $T = \frac{1}{\upsilon} = \frac{1}{500}$ s

The time period between successive compressions from the source is equal to the time period of the tone, *i.e.*, (1/500) s and it has nothing to do with the distance (450 m) of the person from the source provided the sound wave reaches the person.

11.

	Loudness	Intensity
(i)	It is not an entirely physical quantity.	It is a physical quantity which can be accurately measured.
(ii)	It depends upon (i) sensitivity of the ear and (ii) intensity of sound.	It does not depend upon the sensitivity of the ear.
(iii)	It has a subjective existence.	It has an objective existence.

12. The speed of sound in air = 346 m s^{-1}.

The speed of sound in water = 1531 m s^{-1}.

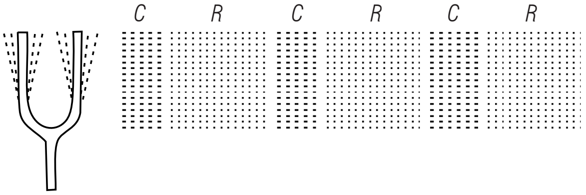
The speed of sound in iron = 5950 m s^{-1}.

$\therefore$ The speed of sound in iron is greater and sound travels fastest in iron.

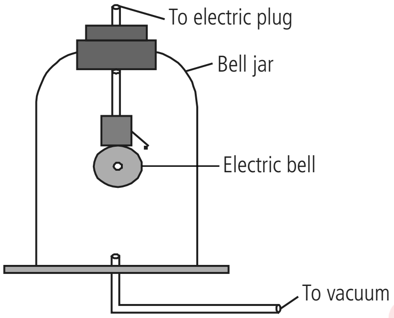
13. Loudness is a physiological response of the ear to the intensity of sound. Loudness of a sound depends on the amplitude of the vibration producing that sound. Greater is the amplitude of vibration, louder is the sound produced by it. The amplitude of the sound depends upon the force with which an object is made to vibrate. The loudness of a sound also depends on the quantity of air that is made to vibrate.

14. Sound is a form of energy and it is produced due to vibrations of different types of object, *e.g.*, a vibrating tuning fork, a bell, wires in a sitar and a violin etc.

15. (i) When a vibrating object moves forward, it pushes the air in front of it and compresses the air creating a region of high pressure called compression (C).
(ii) It starts moving away from the surface of the vibrating object.
(iii) As this occurs the surface moves backward creating a region of low pressure called rarefaction (R).



16. Take an electric bell and an air tight glass bell jar. The electric bell is suspended inside an air tight glass jar which is connected to a vacuum pump.



Bell jar experiment

Working : (i) When we press the switch, we will be able to hear the bell.
(ii) When the air in the jar is pumped out gradually, the sound becomes feeble although the same amount of current is flowing through the bell.
(iii) When the air is removed completely, we will not be able to hear the sound of the bell.
Conclusion : This experiment shows that sound requires a medium for its propagation.

17. A sound wave is called a longitudinal wave as it travels in a medium in the form of compressions and rarefactions where the particles of the medium vibrate in a direction which is parallel to the direction of propagation of the sound wave.

18. The quality (or timbre) of sound is that characteristic which enables us to distinguish one sound from the other even when these are of the same pitch and loudness. Each person has its own quality of sound and it is this characteristic which enables us to identify a person from others even without looking at him (*i.e.*, in a dark room).

19. The speed of light (c) is greater than the speed of sound (v) by a factor of 10^6 as

$$\frac{c}{v} = \frac{3\times10^8 \text{ m s}^{-1}}{340 \text{ m s}^{-1}} \approx 10^6$$

Thus, the flash of light is seen earlier than the sound of thunder even though both are produced simultaneously.

20. Speed of sound in air, $v_1 = 346 \text{ m s}^{-1}$
Speed of sound in aluminium, $v_2 = 6420 \text{ m s}^{-1}$
Let the length of the aluminium rod $= x$ m

We know that, speed $= \frac{\text{distance}}{\text{time}}$

$\therefore$ time $= \frac{\text{distance}}{\text{speed}}$

Time taken in air $= \frac{x}{346}$ s ($\because$ distance $= x$ m)

Time taken in aluminium $= \frac{x}{6420}$ s

Required ratio $= \frac{x}{346} \div \frac{x}{6420} = \frac{x}{346} \times \frac{6420}{x} = 18.55$

21. Frequency of sound = 100 Hz
Time taken = 1 minute = 60 s

We know, frequency $= \frac{\text{number of oscillations}}{\text{time taken}}$

$\therefore$ No. of oscillations $= \upsilon \times t = 100 \times 60$
$= 6000$ times.

Topic 2

1. Given, speed of sound in air = 342 m s^{-1}.
Time taken by echo to return, $t = 3$ s
If d is the distance between the source and the reflecting surface, distance covered by sound in time $t = d + d = 2d$
(distance d while going to the reflecting surface and distance d while returning back)
As distance = speed of sound × time,
$2d = 342 \text{ m s}^{-1} \times 3 \text{ s} = 1026$ m or $d = 513$ m

2. The ceilings of the concert halls are curved to ensure that after reflection from the ceilings, sound reaches all corners of the hall.

3. Yes, sound follows the same laws of reflection as light does because,
(i) Angle of incidence of sound is always equal to angle of reflection of sound waves.
(ii) The direction in which sound is incident, the direction in which it is reflected and normal all lie in the same plane.

4. The minimum distance (d) for the distinct echo to be heard (say at 22°C) is 17.2 m (as $2d = vt = 344 \times 0.1 = 34.4$ m). On a hotter day, the temperature increases and the speed of sound in air also increases. For example, at 40°C, speed of sound, *i.e.* $v = 356 \text{ m s}^{-1}$ and as such $2d = 356 \times 0.1 = 35.6$ m or $d = 17.8$ m.
Thus, if the distance of the reflecting surface and the source of sound remains the same (*i.e.*, 17.2 m), no echo is heard on the hotter day as the minimum distance now required is 17.8 m.

5. Ear Trumpet : It is a sort of machine used by persons who are hard of hearing. The sound energy received by the wide end of the trumpet is connected into a much smaller area at the narrow end by multiple reflections. The narrow end of the trumpet which is inserted in the ear delivers the entire amount of energy falling on the wide end which makes the inaudible sound audible to the user.

Stethoscope : It is a medical instrument used frequently by doctors for making a rough diagnosis of the diseases existing inside the body at places which are either inaccessible or accessible only through major operations.

6. Here, height through which the stone falls, $h = 500$ m speed of sound, $v = 340\text{ m s}^{-1}$, $g = 10\text{ m s}^{-2}$

If t is the time taken by the stone to fall through h, then

$$h = \frac{1}{2}gt^2 \text{ or } t = \sqrt{\frac{2h}{g}} \Rightarrow t = \sqrt{\frac{2\times 500}{10}} = 10\text{ s}$$

Further, if t' is the time taken by sound (produced as a result of splashing) to travel to the top of the tower,

$$t' = \frac{h}{v} = \frac{500}{340} = 1.47\text{ s}$$

Time after which the splash is heard at the top of the tower

$= t + t' = 10\text{ s} + 1.47\text{ s} = 11.47\text{ s}$

7. The persistence of sound in an auditorium as a result of repeated reflections of sound is called reverberation. To reduce the undesirable effects due to reverberation, roofs and walls of the auditorium are generally covered with sound absorbent materials like compressed fiberboard, rough plaster, glass wool etc. The furniture is upholstered and floor is carpeted.

Topic 3

1. **(a)** Frequencies associated with infrasound is less than 20 Hz.

(b) Frequencies associated with ultrasound is greater than 2×10^4 Hz.

2. Here, $\upsilon_1 = 20$ Hz and

$\upsilon_2 = 20\text{ kHz} = 20 \times 10^3$ Hz, speed of sound, $v = 344\text{ m s}^{-1}$

Clearly, $\lambda_1 = \frac{v}{\upsilon_1} = \frac{344}{20} = 17.2\text{ m}$

and, $\lambda_2 = \frac{v}{\upsilon_2} = \frac{344}{20\times 10^3} = 0.0172\text{ m}$

3. The ultrasonic waves emitted by the bat are reflected from the prey (*e.g.*, an insect) and are detected by bat's ears as shown in figure.

The nature of reflected waves tells the bat :

(i) the location and (ii) the nature of its prey.

4. Ultrasound is used to clean parts located in hard-to-reach places, *i.e.*, 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 solutions. Due to the high frequency, the dust particles / grease get detached and drop out. The objects thus get thoroughly cleaned.

5. Ultrasounds can be used to detect cracks and flaws in metal blocks. Metallic components are used in the construction of big structures like buildings, bridges, machines and scientific equipment. The cracks or holes inside the metal blocks, which are invisible from outside reduces the strength of the structure. Ultrasonic waves are allowed to pass through the metallic block and detectors are used to detect the transmitted waves. If there is even a small defect, the ultrasound gets reflected back indicating the presence of the flaw or defect.