UNIT 11

SOUND

After studying this unit, the students will be able to:

- **a)** Explain how sound is produced by vibrating sources and that sound waves require a material medium for their propagation.
- **b)** Describe the longitudinal nature of sound waves (as a series of compressions and rarefactions).
- **c)** Define the terms pitch, loudness and quality of sound.
- **d)** Describe the effect of change in amplitude on loudness and the effect of change in frequency on pitch of sound.
- **e)** Define intensity and state its SI unit.
- **f)** Describe what is meant by intensity level and give its unit
- **g)** Explain that noise, is a nuisance.
- **h)** Describe how reflection of sound may produce echo.
- **)** Describe audible frequency range.
- **j)** Describe the importance of acoustic protection.
- **k)** Solve problems based on mathematical relations learnt in this unit.

Q.1 What are sound waves? What is the necessary condition for the production of sound?

Answer

Like other waves sound is also produced by vibrating bodies. Due to vibration of bodies the air around them also vibrates and the air vibration produces sensation of sound in our ear. For example, in a guitar, sound is produced due to the vibrations of its strings.

Fig. 11.1: Vibrations of guitar strings produce sound waves.

Our voice results from the vibrations of our vocal cords. Human heart beats and vibrations of other organs like lungs also produce sound waves. Doctors use stethoscope to hear this sound.

Necessary condition for the production of sound

Activity (1)

In school laboratories, we use a device called tuning fork to produce particular sound. If we strike the tuning fork against rubber hammer the tuning fork will begin to vibrate. We can hear the sound produced by tuning, fork by bringing it near our car.

We can also feel the vibration by slightly touching one of the prongs of the vibrating tuning fork with a plastic ball suspended from a thread.

Touch the 'ball gently with the prong of the vibrating tuning fork. The tuning fork will push the ball because of its vibration. Now if we dip the vibrating tuning fork into a glass of water, we will see a splash. This is due vibrations produced in the prongs of the tuning fork.

From this activity we can conclude that sound is produced by vibrating bodies.

For your information

Stethoscopes operate on the transmission of sound from the chest-piece, via air-filled hollow tubes, to the listener's ears. The chest-piece usually consists of a plastic disc called diaphragm. If the diaphragm is placed on the patient's body sounds vibrate the diaphragm, creating acoustic pressure waves which after multiple reflection travel up the tubing to the doctor's ears.

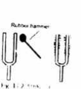


Fig. 11.2 [illegible]

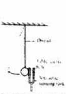


Fig. 11.3 Production of sound waves from a vibrating tuning fork

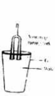


Fig. 11.4

Activity (2)

Unlike light waves which are electromagnetic in nature and can also pass through vacuum, sound waves required some material medium for their propagation. This can be proved by bell Jar apparatus as shown in the fig. 11.5.

The bell jar is on the platform of a vacuum pump. An electric bell is suspended in the, bell jar with the help of two wires connected to a power supply. By setting ON the power supply, electric supply will begin to ring. We can hear the sound of the bell.

Now start pumping out air from the jar by means of a vacuum pump. The sound of the bell starts becoming more and more feeble, and eventually dies out, » although bell is still ringing. When we put the air back into the jar, we can hear the sound of the bell again.

From this activity we conclude that sound waves can only travel / propagate in the presence of air (medium).

For your Information
A sound wave with a frequency of 3500 Hz and an intensity of 80 decibels sounds about twice as loud to us as a sound of 125 Hz and 80 decibels. It is because our ears are more sensitive to the 3500-Hz sound than to the 125 Hz. Therefore intensity by itself does not mean loudness. Loudness is how our ears detect and our brains perceive, the intensity of sound waves.

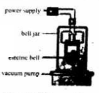


Fig. 11.5 Bell jar apparatus

Q.2 Write about the longitudinal nature of sound waves?

Answer

Propagation of sound waves produced by vibrating tuning fork can be understood by a vibrating tuning fork as shown in fig. 11.6. Before the vibration of tuning fork density of air molecules on the right side is uniform (a).

When the right prong of tuning fork moves from mean position '0' to 'B' (b), it exerts some pressure on the adjacent layer of air molecules and produces a compression. This compressed air layer in turn compresses the layer-next to it and so on. A moment later the prong begins to move from B towards A as shown in fig. 11.6 (c).

Now the pressure in the adjacent layer decreases and a rarefaction is produced. This rarefaction is transferred to the air layer next to it and so on. As the tuning fork moves back and forth rapidly a series of compressions and rare factions are created in the air in this way, sound wave propagates through the air.

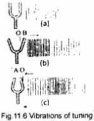


Fig 11.6 Vibrations of tuning fork after striking with a rubber hammer

As In the figure the direction of propagation of sound waves is 'along the direction of oscillating air molecules. This shows the longitudinal compressional nature of sound waves. "

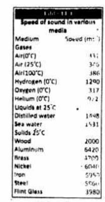
Wave Length

Distance between two consecutive compressions or rarefaction is the wave length of sound wave.

Q.3 Write a note on the characteristics of sound?

Answer

Sounds of different objects can be distinguished on the basis of different characteristics as described below:



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Speed of sound in various media

Medium	Speed (m s⁻¹)
Gases	
Air(0°C)	331
Air (25°C)	346
Air(100°C)	386
Hydrogen (0°C)	1290
Oxygen (0°C)	317
Helium (0°C)	972
Liquids at 25°C	
Distilled water	1498
Sea water	1531
Solids 25°C	
Wood	2000
Aluminum	6420
Brass	4700
Nickel	6040
Iron	5950
Steel	5600
Flint Glass	3980

Loudness

Loudness is the characteristic of sound by which loud and faint sounds can be distinguished.

Example

When we talk to our friends, our voice is low, but when we address a public gathering our voice is loud. Loudness of a sound depends upon the following main factors.

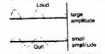


Fig 11.7: Variation of loudness with amplitude

Amplitude of the vibrating body

Loudness of the sound varies directly with the amplitude of the vibrating body.

Example

Sitar will produce loud sound on plucking its wires violently and same with drum when beaten forcefully.

Area of the vibrating body

Large area of the vibrating body produces more loud sound and vice versa.

Example

If we strike a tuning fork on a rubber pad, a feeble sound will be heard. But if the vibrating tuning fork is placed vertically on the surface of the bench, we will hear a louder sound.

Distance from the vibrating body

It is observed that the amplitude of the sound is decreased by increasing the distance between the source of sound and the listener and vice versa.

Example

If No listeners A and B are standing at different distances from the horn played by the train then the listener A who is at less distance will hear more loud sound as compared to the other who is comparatively at more distance.

Interesting information
Some people use silent whistle to call dogs whose frequency lies between 20,000 Hz. It is silent for humans but not for dogs. Because the audible frequency range for dogs is much higher.
For your information
Thin walled glass goblets can vibrate when hit by sound waves. This is due to a phenomenon of sound known as resonance. Some singers can produce a loud note of particular frequency such that it vibrate the glass so much that it shatters.

Pitch

Pitch is the characteristic of sound by which we can distinguish between a shrill and a grave sound.

A higher pitch means a higher frequency and vice versa.

Example

The voice of ladies and children is shrill and of high pitch (frequency).

Quality

The characteristic of sound by which we can distinguish-between two sounds of same loudness and pitch is called quality.

Example

While standing outside a room, we can distinguish between the notes of a piano and a flute played inside the room.

For your information

Intensity (of Sound)

Sound energy passing per second through a unit area held perpendicular to the direction of propagation of sound waves is called intensity of sound.

The unit of intensity of sound.is "Watt per square meter" (Wm^{-2}).

Q.4 What do you mean by the term intensity level of the sound? Name and define the unit of intensity level of sound?

Answer

Sound intensity level

The human ear responds to the intensities ranging from 10^{-2} Wm^{-2} to more than I Wm^{-2} (which is loud enough to be painful).

Because the range is so wide; intensities are sealed by factors often. The barely audible and the faintest intensity of sound i.e. $10^{-12} Wm^{2}$ is taken as reference intensity, called zero bel (a unit named after Alexander Graham Bell)

The loudness of sound depends not only on the intensity of sound but also on the physical condition of the ear.

The human ear is more sensitive to some frequencies rather than the others.

The loudness (L) of a sound is directly proportional to the logarithm of intensity i.e.

$$L \ \alpha \ \log I$$

$$L = K \log I \text{ ---------- } (1)$$

Where 'k' is a constant of proportionality.

Let 'L_0' be the loudness of the faintest audible sound of intensity L, and L be the loudness of an unknown sound of intensity 'I', then eq. (I)can be written as:

$$L_o = K \log I_o \text{..........(2)}$$

Subtracting eq. (1) from eq. (2), we get.

$$L - L_o = K(\log I - \log I_o)$$

$$= K \log I / I_o$$

This difference ($L - L_0$) between the loudness 'L' of an unknown sound and the loudness "L_o," is called the intensity level of the unknown sound. Therefore, the intensity level of an unknown sound is given by.

$$\text{Sound Level} = K \log I / I_o \text{..........(3)}$$

The value of 'k' not only depends on the units of 'I' and 'I_0' but also on the unit of intensity level.

If intensity I of any unknown sound is 10 times greater than the intensity in of the faintest audible sound i.e. $I = 10 I_0$ and the intensity level of such a sound is taken as unit called "bel". The value of 'k' becomes 1. So, eq. (3) becomes:

Sound level = I/I_0 (bel) (5)

bel is a very large unit of intensity level of a sound. Generally, a smaller unit called decibel is used. Decibel is abbreviated as (dB). It must be remembered that I bel is equal to (H), if the intensity level is measured in decibels. eq. (4) becomes.

$$\text{Sound level} = I / I_o (bel) \text{..........(5)}$$

Using eq. (5) we can construct a scale for measuring the intensity level of sound. Such scale is known as "decibel scale".

$$\text{Sound level} = 10 I / I_o (bel) \text{..........(4)}$$

Q.5 What is the reflection (echo) of sound? Give one example?

Answer

Echo (Reflection of sound): Definition

When sound is incident on the surface' of a medium, it bounces back into the 'first medium. This phenomenon is called echo or reflection of sound.

Explanation

The sensation of sound persists in our brain for about 0.1 S. To hear a clear echo, the time interval between our sound and the reflected sound must be at least 0.1

S. If the speed of sound is supposed to be 340 ms^{-1}, the total distance covered by the echo should be at least

340 ms^{-1} x 0.1s = 34 m. Thus, for hearing distinct echoes, the minimum distance of the obstacle from the source of sound must be half of the distance that is 17m.

Do you know?
Elephants use low frequency sound waves to communicate with one another. Their large ears enable them to detect these low frequency sound waves, which have relatively long wavelengths. Elephants can effectively communicate in this way, even when they are separated by many kilometres.

Activity

Take two identical plastic pipes of suitable length as shown in the figure 11.10.

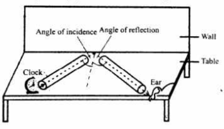


Fig. 11.10: Reflection of sound

1) Arrange the pipes on a table near wait.

2) Place a clock near the open end of one of the pipes and try to hear the sound of the clock through the other pipe.

3) Adjust the position of the pipes so that you can hear the sound of the clock clearly.

4) Now measure the angle of incidence and reflection and relationship between the angles.

5) Lift the pipe on the right vertically to a small height and we will observe that the sound will start becoming fainter and finally no sound will be heard at some certain distance.

Q.6 What is the effect of the medium on the speed of sound?

Answer

Sound waves can be transmitted by any medium containing particles that can vibrate. It cannot pass through vacuum. However, the nature of the medium will affect the speed of the sound waves. In general, the speed of sound in liquids is five times that in gases the speed of sound in solids is about fifteen times that in gases.

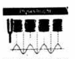
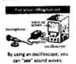


Illustration of longitudinal wave formed by vibrating tuning fork in the air. Compressions are places where air pressure is slightly higher than the surrounding air pressure due to high density of air particles. While rarefactions are the regions correspond to low air pressure due to low density of air particles



By using an oscilloscope, you can "see" sound waves.

The speed of sound in air is affected by changes in some physical conditions such as

Temperature, pressure and humidity etc.

The speed of sound in air is 343 ms^{-1} atone atmosphere of pressure and room temperature (21°C). The speed varies with temperature and humidity. The speed of sound in solids and liquids in faster than in air.

Following relation can be used to find the speed of sound.

$$v = f\lambda$$

Where 'v is the speed, "f" is the frequency and 'λ' is the wavelength of sound wave.

Q7 How can you find the speed of sound by echo method? What factors can affect the accuracy of this method.

Answer

To measure the speed of sound, the following experiment can be performed:

Apparatus

Measuring tape. Stop watch, flat wall that can produce a good echo.

Tidbits
Bats can hear frequencies up to 120,000 Hz. Other animals cannot hear such high-pitched sounds. Mice can hear frequencies up to 100,000Hz, dogs up to 35,000Hz, and cats up to 25,000Hz. Humans hear sounds only upto about 20,000Hz, but children can usually hear higher-frequency sounds than adults.

1) Use the tape to measure a distance of 50 m from the wall.

2) Now clap your hands in front of the wall at a distance of 50 meters and check if you can clearly hear an echo from the wall. Make sure the echo is not coming from any other wall in the area.

The time taken by the sound to travel 100 meters is the time difference, between the clap and the echo.

3) Now restart the clapping and Start the stop watch at the first clap. Count the number of claps, and stop the clapping and the stopwatch when you hear the echo of the (say) 10th clap.

4) Now find the average time for 10 claps. After calculating the time interval 't' between claps and using the formula s=vt. We can calculate the speed of the sound.

Factors which can affect the accuracy of this method

Following factors can affect the accuracy of this method:

1) The wall from where we get echo (reflection of sound) is not smooth.

2) The echo may come from some other wall.

3) Human reaction time in using the stop watch may affect the accuracy.

4) The speed of sound in air is affected by changes in some physical conditions such as temperature, pressure and humidity so accuracy in the measurement of speed of sound can be reduced;

Q.8 What is noise pollution? Explain that noise is a nuisance?

Answer

We enjoy the programmes of radio and television by hearing sounds of different qualities in musical programmes. We hear sound produced by musical instruments such as flute, harmonium, violin, drum etc..

Sound travels
Sound waves

Sound of these instruments cast pleasant effect on our ears.

Musical sounds

Such sounds which are pleasant to our ears are called musical sounds. These sounds cast pleasant effect on our ears.

Noise

Sound which have jarring and unpleasant effect on our ears is called noise. Like, sound of machinery the slamming of a door, the sounds of trafficking hill. They also observed a young city.

Noise corresponds to irregular and sudden vibrations produced by some sounds.

1) Noise pollution has 'become a major issue of concern in big cities

2) Noise is an undesirable sound that is harmful for health of humans and other species.

3) Transportation equipment and heavy machinery are the main sources of noise pollution.

For example; noise of machinery in industrial areas loud vehicle horns, hooters and alarms.

4) Noise has negative effects on human health as it can cause conditions such as hearing loss, sleep disturbances, aggression, hypertension, high stress levels.

Interesting Information
Researchers in 1993 observed giraffes to stop and wait for others giraffes that were out of sight over hill. They also observed a young male giraffe who tried to break through high brick wall to get to his mother. Yet the researchers heard 'nothing, very long wavelength sound that turn (diffract) over the hilltop, and also around the brick wall.

5) Noise can also cause accidents by interfering with communication and warning signals.

The safe level of noise depends upon two factors:

1) The level (volume) of the noise; and the period of exposure to the noise.

The level of noise recommended in most countries is usually 85-90 dB over an eight-hour work day.

2) Noise pollution can be reduced to acceptable level by replacing the noisy machinery with environment friendly machinery and equipment, putting sound reducing barriers, or using hearing protection devices.

Q.9 Describe the importance of acoustic protection?

Answer

Acoustic protection

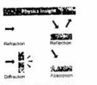
"'The technique or method used to absorb undesirable sounds by soft and porous surfaces is called acoustic protection.

Importance of acoustic

Reflection of sound is more prominent if the surface is rigid and smooth, and less if the surface is soft and irregular.

Soft porous materials, such as draperies and rugs absorb large amount of energy and thus quiet echoes and softening noises.

Thus, by using such material in noisy places we can reduce the level of noise pollution. However, if she surfaces of classrooms or public halls are too absorbent," the sound level may be low of the audience.



Sound displays all the properties of waves when it interacts with materials and boundaries

For your information

The phrase "blind as a bat" is a false statement. Bats have some vision using light, but when placed in pitch-black rooms crisscrossed with fine wires, they can easily fly around and unerringly locate tiny flying insects for food. We usually assume that vision requires light but both bats and dolphins have the ability to "see" using sound waves. Research in science and technology has developed "eyes" that enable humans also to see using sound waves.

Sometimes when sound reflects from the walls, ceiling, and floor of a room, the reflecting surfaces are too reflective and the second becomes garbled. This is due to multiple reflections called "reverberations."

In the design of lecture halls, auditorium or theatre halls, a balance must be achieved between reverberation and absorption.

It is often advantageous to place reflective surfaces behind stage to direct sound to the audience.

Generally, the ceilings of lecture halls, conference halls and theatre halls are curved so that sound after reflection may reach all the corners of the hall.

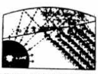


Fig. 11.11 Curved ceiling of a conference hall.

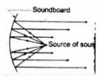


Fig. 11.12 Soundboard used in a big hall.

Sometimes curved sound boards are placed behind the stage so that sound after reflection Is distributed evenly across the hall.

Q.10 What is the audible frequency range? What are the uses of ultrasound in medicine? Answer

Audible frequency range:

The range of the frequencies which a human ear can hear is called the audible frequency range. It his between 20Hz and 20.000 Hz.

The frequency below 20Hz is not audible for human ear and is called "infrasonic" and the frequency above 20,000 Hz is also not audible for human ear and is headphones that reduce the called "Ultrasonic or Ultrasound."

For your information

Peak
Engine noise is cancelled out
Trough

Pilots wear special headphones that reduce the roar of an airplane engine to a quiet hum.

Ultrasound: (uses):

1) Ultrasonic waves carry more energy and higher frequency than audible sound waves. Therefore, according to the wave equation. v =fλ the wave length of ultrasonic waves is very small and is very useful for detecting very mall objects.
2) Ultrasonic are utilized in medical and technical fields. '
3) In medical field ultrasonic waves are used to diagnose and treat different ailments. For diagnosis of different diseases, ultrasonic waves are made to enter the human body through transmitters. These waves are detected differently by different organs of the body on the screen as shown in figure 11.13. Such an image helps in detecting the defects in these organs.
4) Powerful ultrasound is now being used to remove blood clots formed in the arteries.
5) Ultrasound can also be used to get the pictures of thyroid gland for diagnosis purposes.
6) Ultrasound is used to locate under water depths or is used for locating objects lying deep on the ocean floor, etc.. The technique is called "SONAR". (Sound navigation and ranging).

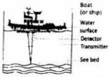


Fig. 11.14: Ultrasonic are used to measure the depth of water by echo method.

Fig. 11.13: 1 Doctors are taking ultrasound test of a patient with an ultrasound machine.

The sound waves are sent from a transmitter and a receiver collects the reflected sound as shown in the figure 11.14.

The time lapse is calculated, knowing the speed of sound in water, the distance of the object from the ocean surface can be estimated.

7) SONAR ranging is also used to see the shape and the size of the object. Cracks appear in the interior of moving parts of high-speed heavy machines such as turbines, engines of ships and airplanes due to excessive use. These cracks are not visible from outside but they can be very dangerous. Such cracks can be detected by ultrasonic.
   A powerful beam of ultrasound is made to pass through these defective parts. While passing, these waves are reflected by the surface of these cracks and flaws. The comparison of the ultrasonic waves reflected from crack and from the surfaces of these parts can give a clue of the existence of the cracks.
8) Germs and bacteria in liquids can also be destroyed by using high intensity ultrasonic waves.

MULTIPLE CHOICE QUESTIONS

Choose the correct answer from the following choices:

i) Which of the following is an example of simple harmonic motion?

a) Motion of a simple pendulum **b)** The motion of ceiling fan

c) The spinning of the Earth on its axis **d)** A bouncing ball on a floor

ii) If the mass of the bob of a pendulum is increased by a factor of 3, the period of the pendulum's motion will:

a) be increased by a factor of 2 **b)** remain the same

c) be decreased by a factor of 2 **d)** be decreased by a factor of 4

iii) Which of the following devices can be used to produce both a transverse and longitudinal wave?

a) a string **b)** a ripple tank

c) a helical spring (slinky) **d)** a tuning fork

iv) Waves transfer:

a) Energy **b)** frequency

c) wavelength **d)** velocity

v) Which of the following is a method of energy transfer?

a) Conduction **b)** Radiation

c) Wave motion **d)** All of these

vi) In a vacuum all electromagnetic waves have the same:

a) Speed **b)** frequency

c) amplitude **d)** wavelength

vii) A large ripple tank with a vibrator working at a frequency of 30 Hz produces 25 complete waves in a distance of 50cm. The velocity of the wave is:

a) 53 cms^{-1} **b)** 60 cms^{-1}

c) 750 cms^{-1} **d)** 1500 cms^{-1}

viii) Which of the following characteristics of a wave is independent of the others:

a) speed **b)** frequency

c) amplitude **d)** wavelength

ix) The relation between v, f and A of a wave is:

a) $vf = \lambda$ **b)** $f\lambda = v$

c) $v\lambda = f$ **d)** $v = \frac{\lambda}{f}$

Answers

(i) a **(ii)** b **(iii)** c **(iv)** a **(v)** d **(vi)** a

(vii) b **(viii)** a **(ix)** b

Conceptual Questions

10. 1 If the length of a simple pendulum is doubled what will be the change in its time period?

Answer

Let the initial length of simple pendulum is ' l ', and after making it double, it becomes

'l' ', i.e. L' = 2l.

Time period of simple pendulum is given by,

$$T = 2\pi\sqrt{\frac{l}{g}} \text{..........(1)}$$

And $$T' = 2\pi\sqrt{\frac{l'}{g}}$$

Or $$T' = 2\pi\sqrt{\frac{2l}{g}}$$

$$T' = \sqrt{2}\left[2\pi\sqrt{\frac{l}{g}}\right]$$

Where, $$2\pi\sqrt{\frac{l}{g}} = T$$

So, $$T' = \sqrt{2}T$$

$$T' = 1.41T$$

It shows that the time period of simple pendulum will increase by 1.41 times by making the length double.

10. 2 A ball is dropped from a certain height onto the floor and keeps bouncing. Is the motion or the ball simple harmonic? Explain.

Answer

No, in case of a bouncing ball, when it hits the floor then there will be no restoring force or acceleration opposite to the downward displacement. So, it does not fulfil the condition of simple harmonic motion. Secondly, in case of bouncing ball, the acceleration due to gravity remains the same, while for SHM the acceleration should vary at different points during the motion of the body.

10. 3 A student performed two experiments with a simple pendulum. He/She used two bobs of different masses by keeping other parameters constant. To his/her astonishment the time period of the pendulum did not change! Why?

Answer

Time period of simple pendulum only depends upon the length of simple pendulum as given in its formula, i.e.

$$T = 2\pi\sqrt{\frac{l}{g}}$$

The value of 'g' will remain constant up to a certain height. So, by changing mass of the bob or amplitude, there will be no effect on the time period, of simple pendulum.

10. 4 What type at waves do not require any material medium for their propagation?

Answer

Mechanical waves: like sound waves, water waves, waves produced in strings or springs etc.

10. 5 Plane waves in the ripple tank undergo refraction when they move from deep to shallow water. What change occurs in the speed of the waves?

Answer

In case of plane waves in the ripple tank when refraction takes place while moving from deep to shallow water. The speed of the wave is decreased due to decrease in wave length while frequency remains the same, as given by wave equation below.

$$v = f\lambda$$

Review Questions

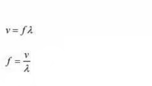
10. 2 Think of several examples in our daily life of motion that are simple harmonic?

Answer

1. Pendulum used in a clock.
2. A boy swinging on a swing.
3. See-saw; when his moved up & down.
4. Human ear drum oscillating back & forth.

10. 6 Draw a transverse wave with an amplitude of 2cm and a wavelength of 4cm. Label a crest and trough on the wave.

Answer



10.10 Does increasing the frequency of a wave also increase its wave length? If not, how are these quantities related?

Answer

No, by increasing frequency, the wave length decreases as given by the following relation,

$$v = f\lambda$$

Or $$f = \frac{v}{\lambda}$$

Or $$f \propto \frac{1}{\lambda}$$ (for constant value of velocity)

[Note: The answer of the remaining questions is given in the topics.]

OBJECTIVE TYPE QUESTIONS & ANSWERS

Q2. Give short Answers.

1. How sound is produced?

Answer

Sound is form of energy, which is produced by a vibrating body.

Whenever a sound is produced, the vibrations of the sounding body can be observed.

2. What is tuning-fork?

Answer

Tuning fork is used in the laboratory for producing sounds of a particular frequency.

A tuning fork has U- shaped prongs with a stem at the bottom when we strike a tuning fork on a rubber pad a sound 13 heard and prongs of the tuning fork start vibrating

3. What is the nature of sound?

Answer

Vibrating bodies produced sounds. During vibratory motion, the vibrating body moves to and fro around its rest position and produces compressional waves in

the surrounding. These compressional waves are called sound waves. These waves travel from one place to another.

4. Do sound waves need material medium for their propagation?

Answer

Yes, sound waves need material medium for their propagation. Sound waves can travel through air, gases water and solids. It means that a material medium is necessary for the propagation of sound waves.

5. In a humid day, a louder sound is heard. Why?

Answer

In a humid day, water vapors are greater in air. Sound travel with greater speed in liquids than gases, that's why a louder sound is heard in a humid day.

6. What is the main function of eardrum?

Answer

The external ear collects the sound waves and directs them to the eardrum. The sound waves reach the eardrum and starts vibrating. The eardrum also separates the outer and middle ear.

7. Does loudness of a sound depend on the physical condition of the ear?

Answer

Loudness of a sound also depends on the physical condition of the ears of the listener.

A sound appears to be louder to a person with sensitive ears than to a man with defective ear.

8. Differentiate between loudness and intensity of sound.

1.	The characteristics of sound by which a loud and a faint sound can be distinguished is called loudness of sound.	1.	Sound energy flowing per second through a unit area held perpendicular to the direction of sound waves is called intensity of sound
2.	It is not a physical quantity.	2.	It is a physical quantity.
3.	It cannot be measured.	3.	It can be measured accurately.
4.	It depends on the physical condition of the ear.	4.	It independent of the ear.
5.	It does depend upon the intensity of sound.	5.	It does not depend upon the loudness.
6.	It has no unit.	6.	Its unit is Wm^{-2}.

9. Find the intensity level of faintest-audible sound?

Answer

In this case, $I = 10^{-12} Wm^{-2} I_o = 10^{-12} Wm^{-2}$

Intensity level $= k \log \frac{I}{I_o}$

Intensity level $= 10 \log \frac{10^{-12}}{10^{-12}}$

Intensity level $= 10 \log I = 10 \times 10$

Intensity level = 0

10. Find the intensity level of whispering sound?

Answer

In this case, $I = 10^{-10} Wm^{-2} I_o = 10^{-12} Wm^{-2}$

Intensity level $= k \log \frac{I}{I_o}$

Intensity level $= 10 \log \frac{10^{-10}}{10^{-12}}$

Intensity level $= 10 \log 100 = 10 \times 2$

Intensity level $= 20 dB$

11. Define sound.

Answer

Sound is the form of energy, which is produced by a vibrating body.

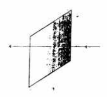
12. What is intensity of sound? Give its unit.

Answer

Intensity of sound

"Sound energy flowing per second through a unit area held perpendicular to the direction of sound waves is called intensity of sound." It is denoted by I.

Unit: SI unit of intensity of sound is watt per square metre (Wm^{-2}).



Mathematically:

$\text{Intensity} = \frac{\text{Energy}}{\text{Area} \times \text{time}}$

13. What is pitch of sound?

Answer

The characteristics of sound by which a shrill sound can be distinguished from a grave one is called the pitch of a sound:

Example: the voice of ladies is of higher pitch than of men.

14. What is loudness of sound?

Answer

The characteristics of sound by which a loud and a faint sound can be distinguished is called loudness of sound.

15. State Weber-Fechner law.

Answer

Weber—Fechner law states that:

"The loudness of a sound is directly proportional to the logarithm of intensity."

$$L \,\alpha\, \log I$$

$$L = cons \tan t \times \log I$$

$$L = k \log I$$

k =constant of proportionality

Where k = constant of proportionality.

16. What is intensity level? Find its relation.

Answer

The difference in loudness of two sounds is called intensity level.

If I and 10 represents the intensities of two sounds waves having loudness L and Lo respectively, then according to Weber—Fechner law

$$L = k \log I$$

And $$L_o = k \log I_o$$

Intensity level $= L - L_o$

Intensity level $= k \log I - k \log I_o$

Intensity level $= k(\log I - \log I_o)$

Intensity level $= k \log \frac{I}{I_o}$

17. Differentiate between ultrasonic and infrasonic.

Answer

The sounds of frequency higher than 20,000 Hz are called ultrasonic.

The sounds of frequency less than 20 Hz are called infrasonic.

18. One what factors the loudness of a sound depends?

Answer

The loudness of a sound depends upon the following factors:

- Amplitude of vibrating body.
- Area of harming body.
- Distance from vibrating body.

19. On what factors the pitch of the sound depends?

Answer

The pitch of the sound depends on the frequency of the sound.

Greater the frequency higher will be the pitch.

0 The voice of woman and children are shriller because of their higher pitch.

20. What is quality of sound?

Answer

It is the property of sound by which we can differentiate between the sounds of the same pitch and intensity coming from different sources.

Example

We can differentiate between sounds coming from violin and piano.

21. Differentiate between noise and musical sound.

Answer

Noise:

A sound, which produces a displeasing effect in the ear, is called a noise.

These sounds have no regular frequency and amplitude.

Examples:

- Sound produced from factories.
- Sound produced from vehicles.

Musical sound:

A sound, which produces a pleasing effect in the ear, is called musical sound.

These sounds have regular frequency and amplitude.

Examples:

Sound of violin and flute.

22. What is resonance?

Answer

The phenomenon, in which there is remarkable increase in the amplitude and loudness of sound when the frequency of air column becomes equal to that of the tuning fork, is called resonance.

23. What is audible frequency range?

Answer

The sound of frequencies above 20 Hz and below 20,000 Hz is only audible.

24. Give some properties of ultrasonic.

Answer

- Ultrasonic waves carry more energy than the ordinary sound waves of the same amplitude.
- Ultrasonic waxes have very high frequency and the particle vibrate with the larger speed.
- These waves can be focused into narrow-beam.
- These waves travel through solids and liquids with very little loss of energy.

25. Why does the sound produced by a tuning fork die out when it is touched by hand?

Answer

When the prongs of' vibrating tuning fork are touched by hand, then these stop their vibrations, so sound produced dies out.

26. Write some uses of ultrasonic.

Answer

Ultrasonic waves are used:

- To diagnose and treat different ailments.
- To find the' sex of a body and its abnormalities before birth.
- To remove blood clots formed in the arteries.
- For the scaling of teeth.
- To crush the kidney stone and remove it.
- To destroy germs and bacteria present in the liquid.

27. How ultrasonic are helpful in industry?

Answer

A power beam of ultrasonic is allowed to pass through the defective parts, while passing, these waves are reflected by the surface of these cracks, which indicates the presence of cracks.

28. How can determine the depth of the ocean be the help of ultrasonic?

Answer

The depth of an ocean can be determined by using ultrasonic. An ultrasonic pulse is sent down towards the ocean bed from the bottom of a ship. This pulse after reflection from the ocean bed reaches the ship, where it is detected. The time taken by the ultrasonic pulse in travelling from the ship to the ocean bed and back is noted. Using this time and the speed of sound in water, the depth of the ocean can be easily determined.

29. What is difference between the sounds produced by tuning fork and violin?

Answer

Violin produces a musical sound. It is observed that both produce the sounds of equal loudness and pitch but these are identified due the difference in their quality.

30. Name the moveable bones of the middle ear?

Answer.

The bones of the middle ear:

1) Hammer **2)** Anvil **3)** Stirrup

31. What are the things necessary for production and propagation of sound?

Answer

Three things are necessary for the production and propagation of sound.

- A vibrating body.
- A material medium.
- Receiver like ear.

32. We cannot hear nuclear explosions occurring on sun. Why?

Answer

We do not hear nuclear explosions because there is no material medium between the sun and the earth. There is a vacuum between the sun and the earth.

33. Can sound waves pass through water?

Answer

Sound waves are longitudinal in nature and can pass through a material medium only and. not through vacuum. -As water is a material medium, sound waves can pass through it.

34. Do the loudness of a sound depends on the amplitude of vibration of the sounding body?

Answer

The loudness of a sound depends on the amplitude of vibration of the sounding body.

- The sound will be loud if the amplitude of vibration is large.
- The sound will be faint or low if the amplitude of vibration is small.

35. On what factors the speed of sound waves depends?

Answer

The speed of sound waves depends on the following two factors:

- The compressibility i.e. elasticity of the medium.
- Inertia i.e. density of the medium.

36. Why Sound waves travel more slowly in gases than in solids?

Answer

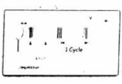
Sound travel more slowly in gases than in solids because gases are more compressible due to smaller density. As a result, the solids have greater elasticity than

37. Differentiate between compression and rarefaction?

Answer

The portion of the wave where crowding of the particles of the medium is maximum is called compression.

The portion of the wave where crowding of the panicles of the medium is minimum called rarefaction.



Funning Fork

38. We see a pendulum vibrating but no sound is heard. Why?

Answei

Sound waves are produced by a vibrating body but are not heard but their frequency is less than 20 Hz. Therefore, the sound wave produced by a vibrating pendulum are not heard.

39. How does the change in temperature affect the velocity of sound?

Answer

Velocity of sound increases by 0.61 ms^{-1} for every 1°C rise in temperature.

40. On what factors the quality 01' sound depends?

Answer

The quality of sound depends on the following factors.

- Number of harmonics and
- Their relative intensities (loudness) present in sound.

41. Differentiate between audible and inaudible sounds.

Answer

Audible sounds:

Those sounds, which can be heard by our ears, are called audible sounds.

Their frequency range is between 20 Hz to 20,000 Hz.

Inaudible sounds:

Those sounds, which cannot be heard by our ears are called in audible sounds.

The sound of frequency below 20 Hz and greater than 20,000 Hz are inaudible sound.

42. What is decibel scale?

Answer

A scale, which is used for measuring the intensity level of sound is known as decibel scale.

43. What is the main use of silent whistle?

Answer

Some people use silent whistle to call dogs whose frequency lies between 20,000 Hz to 25,000 Hz. it is silent for humans but not for dogs because their audible frequency range is much more than humans.

44. On a humid day, a louder sound heard. Why?

Answer

On a humid' day, water vapors are greater in air. Sound travels with greater speed in liquids than gases, that's why a louder sound is heard on humid day.

45. How do we hear a sound?

Answer

The sounding body causes vibrations in the surrounding air. These vibrations reach our ear in the form of compressional waves and in turn set the eardrum into vibrations. Eardrum transfers these vibrations to the inner ear through three bones (hammer, anvil and stirrup). In the inner ear, these vibrations cause changes in the pressure of the, fluid in the cochlea. The hair like endings of the auditory nerve respond to these pressure variations and send this message to brain where it is interpreted as sound.

46. Enumerate the factors that determine loudness 01' a sound.

Answer

The factors that determine the loudness, of sound are:

i) Amplitude of the vibrating body.
ii) Surface area of the vibrating body.
iii) Distance from the vibrating body.
iv) Direction of wind.
v) Moisture in air.

47. Differentiate between intensity and intensity level of a sound.

Answer

Difference between Intensity and Intensity level of a Sound:

	Intensity		**Intensity Level**
1.	The sound energy per second per unit area held perpendicular to the direction of sound waves is called the intensity of the sound.	2.	The difference between the loudness of one sound and the loudness of the faintest audible sound is called the ntensity level of that sound.
2.	The unit of intensity is watt per square meter (W/m^2).	2.	The units are Bet and decibel.
3.	For example, the intensity of threshold Of pain is I W/m^2 .	3.	For example, the intensity level of threshold of pain is I20dB or 12 Bel.

48. Differentiate between pitch and quality of a sound.

Answer

Difference between Pitch and Quality of a Sound:

1.	The characteristics by virtue of which a shrill sound pan be distinguished from c grave one is called pitch of sound.	1.	The characteristics by virtue of which two sounds & of same loudness and pitch cci be distinguished from each other is called quality of the sound.
2.	Pitch of a sound depends upon its frequency. '	2.	Quality of a Fund depends upon the fundamental frequency and the overtones present in the sound.
3.	The voices of women and children are shrill because of high pitch and that of men are grab due to low pitch.	3.	Two notes of same loudness and pitch play separately on a flute and on a piano can be distinguished from each other without actually looking at the instruments due to their quality.

49. What is the relation of a sound with its frequency?

Answer

A sound of high frequency has high pitch and. therefore, it is shrill. Similarly, a sound of low frequency has low pitch and is grave.

50. Give the industrial use of ultrasonic.

Answer

One of the industrial uses of ultrasonic is to determine cracks in the moving parts of heavy-duty machines and engines.

OBJECTIVE TYPE QUESTIONS & ANSWERS

Q1. Each question I: followed by four options encircle the correct option.

1) Sound waves cannot passes through:
a. metals
b. air
c. vacuum
d. water

2) Sound waves travel faster In:
a wood
b. air
c. water
d. copper

3) Ultrasonic was having frequency greater than:
a. 20 kHz
b. 0.2 kHz
c. 10 kHz
d. 5 kHz

4) Sound is a form of energy and it is produced by:
a. air
b. vibrating body
c. heating
d. water

5) Loudness of sound decreases by Increasing
a. no of Vibrations
b. amplitude
c. distance from sounding object
d. none of these

6) By increasing temperature, the speed of sound:
a. increases
b. decreases
c. remains constant
d. becomes double

7) The speed of sound at 0°C in air is:
a. 3 x 108 m/s
b. 1000 m/s
c. -500 m/s
d. 332 m/s

8) Sound energy per unit area per second is called:
a. loudness
b. intensity
c. pitch
d. frequency

9) The magnitude of the sensation produced on the ear by a sound is known as:
a. intensity
b. pitch
c. loudness
d. quality

10) Weber Fechner Law is:
a. $I \propto \log L$
b. $L \propto \log I$
c. $L \propto I$
d. $L \propto \frac{1}{\log I}$

11) The unit of intensity level is:
a. watts
b. watt m^{-2}
c. Joule
d. bel

12) Intensity 1 bel is given by:
a. $K \log\frac{I_o}{I}$
b. $10 \log\frac{I_o}{I}$ db
c. $K \log\frac{I}{I_o}$
d. $K \log\frac{I^2}{I_o}$

13) Decibel is the smaller unit intensity level. 1db is equal to:
a. 0.1 bel
b. 10 bel
c. 100 bel
d. 0.01 bel

14) The characteristic of sound which depends upon frequency is called:
a. loudness
b. pitch
c. quality
d. intensity

15) The pitch of women voice as compared with men voice is:
a. equal
b. low
c. high
d. double

16) Human ear can hear the sound of maximum frequency:
a. 200 Hz
b. 2000
c. 20,000 Hz
d. 20 Hz

17) Sound level for whisper is equal to:
a. 30 dB
b. 20 dB
c. 10.dB
d. 0 dB

18) Product of frequency and time period is:
a. 1
b. 0
c. A
d. v

19) Frequency of waves having length 2m and velocity 340 m/s is:
a. 1020 Hz
b. 680 Hz
c. 340 Hz
d. 170 Hz

20) Speed of sound in air at normal temperature and pressure (NTP) is:
a. 330 ms^{-1}
b. 672 ms^{-1}
c. 712 ms^{-1}
d. 785 ms^{-1}

21) Sound level for ordinary conversion is:
a. 120 dB
b. 60 dB
c. 20 dB
d. 10 dB

22) The faintest audible sound of intensity is 1_0 and its value is:
a. 10^{-2} wm^{-2}
b. 10^{-10} wm^{-2}
c. 10^{-12} wm^{-2}
d. 1 wm^{-2}

23) The unit 01' relative intensity of sound is:
a. Wm^{-2}
b. decibel
c. Joule s^{-1}
d. no unit

24) The characteristic of sound by which two sounds of same loudness and pitch are distinguished from each other is called:
a. pitch
b. quality
c. loudness
d. frequency

25) The sound which has a jarring effect on ear is called:
a. pitch
b. quality
c. noise
d. loudness

26) If the frequency and amplitude of the sound changes in regular manner, the sound will be:
a. noise
b. musical
c. loudness
d. pitch

27) Which of the following waves are produced in resonance tube?
a. transverse waves
b. progressive waves
c. stationary waves
d. none of these

28) The distance between a node and antinode is:
a. λ
b. λ /2
c. λ/4
d. 3/4 λ

29) Which of the following relation is true between wavelengths of stationary wave find the length of air column in first resonance position?
a. λ =4£
b. λ =2£

c. λ =£
d. λ =1/2£

30) Headache and hearing loss is caused by sounds having sound level more than:
a. 60 dB
b. 120 dB
c. 10 dB
d. 80 dB

31) Audible frequency range is:
a. 10 to 1500 Hz.
b. 20 to 20.000 Hz
c. above 20 kHz
d. below 20 kHz

32) The depth of an ocean is measured by using:
a. stationary waves
b. light waves
c. ultrasonic
d. lasers

33) What will be the wavelength of sound of frequency 512 Hz, if speed of sound is 340ms^{-1}.
a. 66 cm
b. 1.5 m
c. 174080 m^{-1}
d. none of these

34) Kidney stones can be crushed and removed out through urine without any surgery by using waves which are called:
a. electromagnetic
b. transverse
c. magnetic
d. ultrasonic

35) The instrument used for producing I sound of particular frequency is:
a. tuning fork A
b. fork
c. hammer
d. drum

36) Sound waves are _____ in nature.
a. functional
b. compression
c. dangerous
d. always ultrasonic

37) Which is not a part of ear?
a. outer ear
b. inner ear
c. middle ear
d. optic nerve

38) Cochlea is present in:
a. outer ear
b. inner ear
c. middle ear
d. ear drum

39) Loudness of sound depends on:
a. amplitude of vibrating body
b. area of vibrating body
c. distance from vibrating body
d. all of above

40) Sound energy flowing per second through a unit area held perpendicular to the direction 01' sound waves is called:

a. intensity b. loudness
c. frequency d. pitch

41) The intensity of sound of train is:

a. 1 wm^{-2} b. 10^{-2} wm^{-2}
c. 3 .wm^{-2} d. 10^{-6} wm^{-2}

42) If the intensity 01' a sound is 10^{-4} wm^{-2}, then equivalent sound level will be:

a. 70 dB b. 80 dB
c. 90 dB d. 100 dB

43) The characteristic of sound by which a shrill sound can be distinguished from a grave one is called:

a. pitch b. frequency
c. note d. node

44) Select the false statement:

a. flute and pianos are musical instruments
b. a pleasant sound is called noise
C. the change in frequency and amplitude of noise is sudden & irregular
d. sound produced by hammering is noisy

45) Which statement is not true?

a. Dogs can hear between 20,000 hertz to 25,000 hertz
b. young children can hear sounds of 20.000 hertz
c. old people cannot hear sound above. 15.000 hertz
d. human ear can hear less than 20 hertz

46) Which is not the use of ultrasonic?

a. in finding sex of the body b. in removing blood clot from arteries
c. in crushing stones in kidney d. in chromatography

47) When the sound waves reach near the ear drum it starts:

a. vibrating b. losing
c. sounding d. resonating

48) If 1= 1 wm^{-2}, then its corresponding intensity level is:

a. l dB b. 0 dB
c. 120 dB d. 60 dB

49) Ultrasounds are used for:

a. scaling of teeth b. crushing kidney stones
c. measuring depth of oceans d. all are true

50) Loudness of sound depends upon:

a. amplitude b. area of vibrating surface
c. direction of wind d. all are true

ANSWERS

No.	Ans.	No.	Ans.	No.	Ans.	No.	Ans.
1	c	2	d	3	a	4	b
5	c	6	a	7	d	8	b
9,	c	10	b	11	d	12	c
13	a	14	b	15	c	16	c
17	b	18	a	19	d	20	a
21	b	22	c	23	d	24	b
25	c	26	b	27	d	28	c
29	a	30	b	31	b	32	c