Sound

This set of questions contains all the possible concepts which could be asked in the examination

Sound

Q.1 What is sound?

Sound is a form of energy emitted by a vibrating object producing sensation of hearing.

Q.2 Write any three characteristics of sound waves.

Following are the properties of sound waves:

- These are longitudinal waves.
- These are Mechanical waves.
- These are a result of vibrations.

Q.3 Energy can neither be created nor be destroyed it can change from one form to another. Does this law apply to sound too?

Yes, sound being a form of energy is created through another form of energy. For example: when we clap our hands we hear sound, this sound is produced due to conversion of muscular energy of our hand to sound energy.

Q.4 What are the different types of sound on the basis of frequencies?

On the basis of frequencies, sound can be:

(a) Infrasound – frequencies below than 20 Hz

(b) Audible sound – frequencies between 20 Hz to 20,000 Hz.

(c) Ultrasound - frequencies above 20,000 Hz

Q.5 What is a supersonic speed?

When the speed of an object exceeds the speed of the sound, then the speed with which the body travels is supersonic speed. For example, aircrafts, bullet, etc. which travels at a higher speed than the speed of sound.

Q.6 When does a body produce sound?

Sound is produced through the to and fro motion of the particles of the medium in which sound travels. These particles vibrate about their mean position forming disturbances in the form of waves.

Q.7 Write a short note on propagation of sound.

Or

Write a short note on how does the sound produced by a vibrating object in a medium reaches our ear.

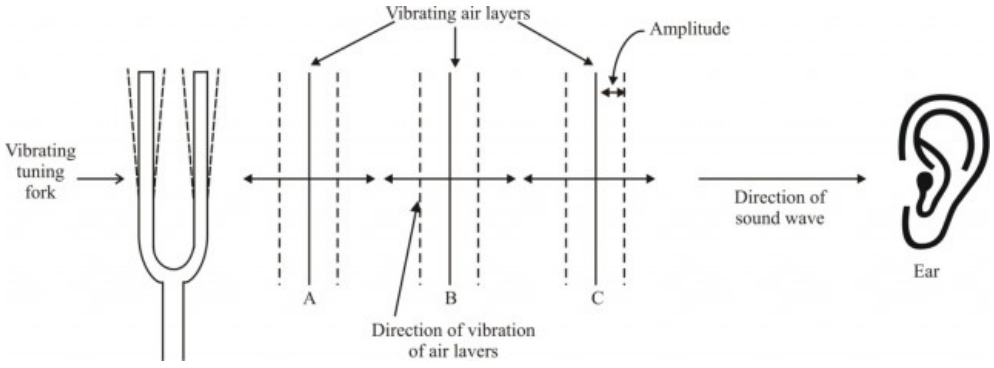
- When sound is produced by the source, for listener to listen the sound passes through certain medium.

- The vibrating object sets the particles of the medium around it into vibration, to and fro motion.

- A particle in contact with the vibrating object moves towards a particular direction. This particle exerts a force on the nearby particles which displaces from its equilibrium position and starts moving towards the same direction in which the original molecule was travelling. After displacing the second particle, the first particle returns to its original position. Similarly, particle second exerts a force on third particle and so on.

- Like this all the particle in between the source and listener vibrates and the sound is conducted to the listener.

Note - the particles of medium do not actually move from the vibrating body, they just vibrates the particles.



Q.8 What is a medium? What are the different mediums in which sound can travel?

Medium is a substance in which sound travels. Without a medium sound cannot propagate. The different medium through which sound travels is gas, liquid and solids.

Q.9 Give reason:

(a) Astronauts cannot talk to each other in space.

(b) A bomb explosion on moon cannot be heard.

(a) Since sound waves being mechanical in nature, needs a material medium to travel and in space there is no atmosphere present. So, sound could not be heard in space. To communicate in this environment they use radio waves, a type of electromagnetic wave which do not use medium for its propagation.

(b) Since moon does not have atmosphere or a medium in which sound can travel so, if there occurs a bomb explosion on moon, it could not be heard by the persons even present on the moon.

Q.10 Which device is used to measure intensity of earthquake?

Seismometers

Q.11 What is decibel?

The intensity of a sound is measured in a unit known as decibel which is denoted by dB.

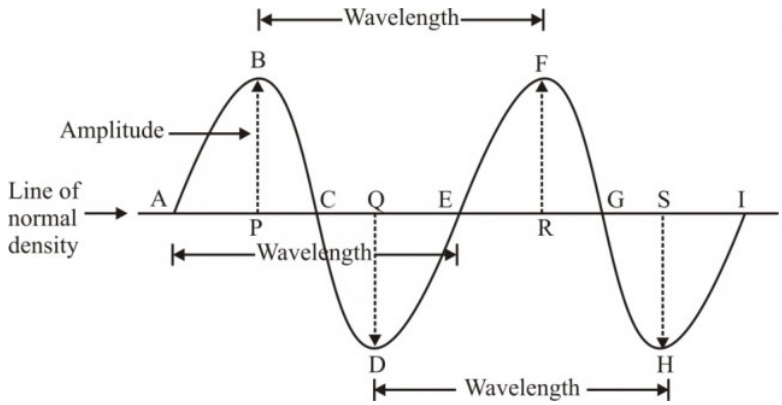
Q.12 Sound waves cannot travel through vacuum. Explain.

Sound waves cannot travel through vacuum as these are mechanical waves and needs a material medium to travel.

Q.13 (a) What is amplitude?

(b) Name the characteristics of sound.

(a) Amplitude of a wave is the maximum displacement of the particles of the medium from their mean position when a wave passes through the medium. It is denoted by A. the SI unit is metre(m).



(b) The characteristics of sound are:

(i) Loudness

(ii) Pitch or Shrillness

(iii) Quality or timbre

Q.14 On which factors does the speed of sound depend?

Underneath are the factors which have an effect on speed of the sound:

(a) Density of the medium through which sound travels: With the increase in density of medium the speed of sound also increases. i.e. Speed of sound in solids>speed of sound in liquids> speed of sound in air.

(b) Temperature: The speed of sound increases with the increase in the temperature i.e. with every 1^{o} increase in temperature the speed of sound increases by 0.6 m/s.

(c) Humidity of air: As the humidity of air increase the speed of sound also increases.

Q.15 We hear two distinct sounds when a person strikes a hammer on the railway lines from a distance. Why is it so?

We hear two distinct sounds, when one hammer on the railway line from a distance because due to the striking of hammer the wave produced would travel by two routes one through solid and other through air. Since the speed of sound in air is different from speed of sound in solid, there would be two distinct sounds heard by the listener.

Q.16 Give reasons:

(a) Sound travels faster in summer than in winter.

(b) Two friends on the surface of the moon cannot talk to each other.

(c) Presence of an advancing train is felt by sticking our ears to rail lines before its sound approaches to the listener by air.

(a) Sound travels faster in summer season than in winter season because, with the increase in temperature speed of sound also increases and in summers temperature is high with respect to the winters.

(b) Two friends on the surface of the moon cannot talk to each other because moon does not have atmosphere or medium for sound to propagate so sound would not produce.

(c) Speed of sound depends upon the density of medium in which it travels. Speed of sound will be greater in substances with greater density i.e. speed of sound in solids > speed of sound in liquids > speed of sound in air. Since rails are made of metal (solid) sound would travel faster in ails than in air (gas).

Q.17 Two persons are holding an iron rod. First person knocked the rod by a hammer. What will be the ratio of times taken by the sound wave in air and in iron to reach the second person?

Suppose, l = length of the iron rod

Time taken by the sound to travel through the iron rod is given by

Similarly, time taken by the sound to travel through the air is given by

Therefore, ratio of time taken by the sound wave in Air and Iron

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Q.18 Why is noise different from music?

S.no.	Noise	Music
1	Frequency is low.	Frequency is high.
2	Sound impulses are irregular.	Sound impulses are regular.
3	Unpleasant in hearing	Pleasant in hearing

Q.19 Define the terms: (a) Tone (b) Note

(a) Tone: A sound produced by single frequency is known as tone.

(b) Note: A sound produced by mixture of frequencies is known as note.

Q.20 What changes occurs in the speed of sound when

(a) It travels from iron to air?

(b) Temperature of the air increases?

(a) Speed of sound decreases when sound waves travel from a solid state to gaseous.

(b) With the rise in temperature of air, the speed of sound travelling in it increases.

Q.21 With the help of an experiment show that sound needs a material medium for its propagation.

System:

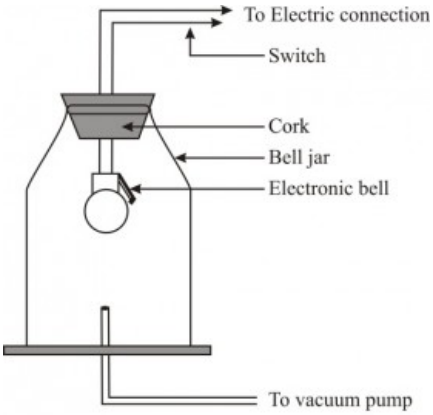
- Suspend an electric bell in an airtight glass bell jar packed with a cork.
- The bell jar is connected to a vacuum pump, from the bottom.

Experiment:

- Press the switch ON, the bell would be heard.
- Now start the vacuum pump.
- With the decrease in the air in the jar through vacuum pump the sound would become paler, with current being flowing constantly.
- When entire air will be removed then no sound will be heard.

Inference:

- Sound needs a material medium to propagate.



Bell jar experiment showing sound cannot travel in vacuum

Q.22 Three friends are made to hear a sound travelling through different media as given below:

Name	Medium
Riya	Steel
Rima	Oxygen
Meher	Ethanol

Which one will hear the sound first? Andwhy?

Speed of sound in solids > Speed of sound in liquids > Speed of sound in gases

Speed of sound depends upon the elasticity and density of a medium. More the density more is the speed of sound.

Therefore, sound will travel fastest in steel and slowest in oxygen. So, Riya would hear the sound

first.

Q.23 Show the propagation of a longitudinal wave showing compression and rarefaction.

Compression are denoted by → A, C, E, G

Rarefaction are denoted by → B, D, F

Q.24 Differentiate between Loudness and Intensity.

S. no.	Loudness	Intensity
1.	It is subjective in nature.	It is objective in nature.
2.	It is not completely physical quantity.	It is a physical quantity.
3.	It depends upon the sensitivity of ear.	It does not depend upon the sensitivity of ear.

4.	Unit of measurement: Decibel(dB)	Unit of measurement: watts per square metre(W/m^2)

Q.25 State the mechanism through which humans can utter sound through their mouth.

The sound produced by our speech is produced through the vibrations of the two vocal cords present in our throat. This vibration is caused by the air approaching from the lungs.

Q.26 Name the characteristic of sound involved when a baby distinguishes her mother's voice with others.

Quality or timber is the characteristic of sound involved here.

Q.27 Give reason for the following:

(a) We hear the sound of a horn of approaching car before the car reaches us.

(b) We hear the sound produced by the humming bees while the sound of vibration of pendulums is not heard.

(c) This is so as the speed of car is much less than that of the sound. So, sound of horn travels faster than the car itself and we can hear the sound earlier than actually see the car.

(d) This is so as the sound produced by the humming of a bee is in the audible range of our hearing unlike the pendulum, which is so low to be heard by humans.

Q.28 How is sound produced when our school bell is struck with a hammer?

Sound is produced when the school bell is struck by the hammer. As this happens the bell starts vibrating. These vibrations then produce disturbances in air, which travels as sound waves to our ear.

Q.29 Define the term:

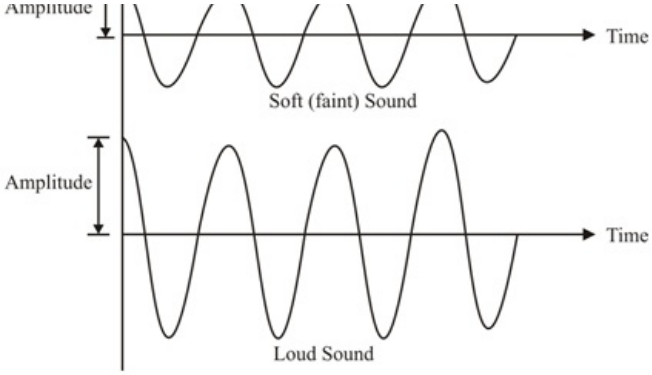
(a) Loudness

(b) Intensity

(c) Pitch

(d) Quality

(a) Loudness: it is the feeling produced in the ear which helps us to differentiate between a loud and a dim sound. The loudness or softness of sound depends upon the amplitude of the wave. The soft sound has small amplitude and louder sound has large amplitude.



(b) Intensity: it is the amount of energy passing at every second through a unit area.

(c) Pitch: it is the characteristic of sound which helps in differentiating between a harsh sound and a dull sound. It depends upon the frequency of vibration. Low pitch sound have low frequency and high pitch sound have high frequency.

(d) Quality: it is the characteristic of sound which differentiate between the two waves of having same pitch and loudness.

Wave

Q.30 What is a wave?

A wave is a disturbance or oscillation travelling in a medium with transfer of energy from one point to another without any actual contact of the points.

There are two type of waves:

(a) Longitudinal Waves

(b) Transverse Waves

Q.31 What do you mean by oscillation?

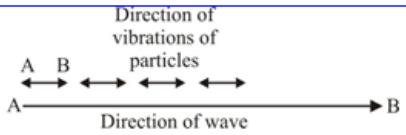
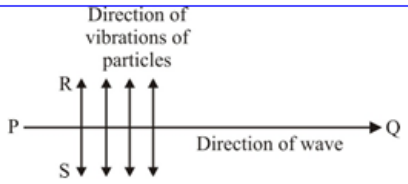
Oscillation is the repetitive variation of the density about a central value or between two or more different values.

Q.32 Why are sound waves longitudinal and mechanical waves?

Sound waves are longitudinal waves as the particles of the medium do to and fro motion in the same direction in which wave moves.

Sound waves are mechanical waves as it needs material medium for its propagation.

Q.33 Differentiate between longitudinal wave and transverse wave.

S.no.	Longitudinal Wave	Transverse Wave
1.	Particles of medium do to and fro motion in direction similar to the direction of wave motion.	Particles of medium do to and fro motion perpendicular to the direction of wave motion.
2.	These are composed of compressions and rarefactions.	These are composed of crests and troughs
3.		
4.	Example: Sound waves	Example: Light waves

Q.34 What is wavelength?

The distance between two consecutive compressions and two consecutive rarefaction is known as wavelength. It is denoted by λ.

Q.35 Express the units of:

(a) Frequency and

(b) Wavelength.

(a) Frequency – hertz (Hz),

(b) Wavelength – metre (m).

Q.36 Define the following terms:

(a) Time period

(b) Frequency of an oscillating body.

(c) State the relation between frequency and time period.

(a) Time period (T): The time taken by a vibrating body to complete one oscillation is known as time period. SI unit is second (s).

(b) Frequency (ν): The number of oscillations completed by a vibrating body in one second is called its frequency. SI unit of frequency is hertz (Hz).

(c) The no. of waves produced in a single second is known as frequency. This concludes that frequency of a wave with time period T would be 1/T.

The frequency of a wave is the reciprocal of its time period.

$$f = \frac{1}{T}$$

Where, f = frequency of the wave

T = Time period of the wave

Q.37 What is compression and rarefaction pulse.

Compression- That part of longitudinal wave in which particles of the medium are closer to one another than they originally are. This is the region of high pressure.

Rarefaction- that part of a longitudinal wave in which particles of the medium are farther apart than they originally are. This is the region of low pressure.

Q.38 Define pulse.

Pulse is a short duration wave generated by a single disturbance in a medium.

Q.39 Write any four differences between mechanical and electromagnetic waves.

S.no.	Mechanical waves	Electromagnetic waves
1.	Require material medium for their propagation.	Do not require material medium for their propagation.
2.	Formed due to vibrations of the particles of the medium	Formed due to varying electric and magnetic fields.
3.	Speed of sound waves is low, 332 m/s at 0°C (air).	Speed of electromagnetic wave is high, 3×10^8 m/s (vacuum).
4.	Can be transverse or longitudinal in nature.	Transverse in nature.

Q.40 State the relation between Time period and Frequency of an oscillating body.

For an oscillating body,

T = time period

ν = frequency

No. of oscillations completed in T second = 1

No. of oscillations completed in 1 second = $\frac{1}{T}$

We know no. of oscillations completed in 1 second = frequency (ν)

Therefore, the relation is shown by, ν = $\frac{1}{T}$

Q.41 A tuning fork oscillates at a frequency of 256 Hz.

(a) What happens to the wavelength of sound generated by tuning fork when the temperature of air increases?

(b) What changes would the wavelength undergo if the temperature rises from 0° to 20°C?

(a) The wavelength of sound will increase. Since, the speed of sound increases with temperature. As, . Therefore, when frequency is constant, wavelength is directly proportional to the speed of sound so when speed of light increases its wavelength also increases.

(b) With every 1^o C rise in temperature the speeds of sound increases by 0.6 m/s.

Therefore, sound speed when temperature changes by 20°C = 0.6 m/s × 20 = 12 m/s.

Increase in wavelength = increase in the speed/ frequency.

$$= \frac{12m/s}{256Hz} = 0.047m$$

The increase in wavelength is 0.047m.

Q.42 (a) What is meant by ‘compression’ and ‘rarefaction’ of a longitudinal wave?

(b) Give well labeled graphical representation of a longitudinal and transverse wave wave.

(a) When sound is produced by to and fro motion compression and rarefaction are produced.

Compression: it is that part of longitudinal wave in which particles of the medium are closer to one another than they are usually. As a result there occurs temporary reduction in the volume of the medium. These are regions of high density and pressure.

Density ↑ Pressure ↑

Rarefaction: it is that part of longitudinal wave in which particles of the medium are farther from one another than they are usually. As a result there occurs temporary increase in the volume of the medium. These are regions of low density and pressure..

Density ↓ Pressure ↓

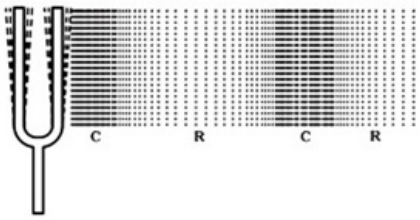
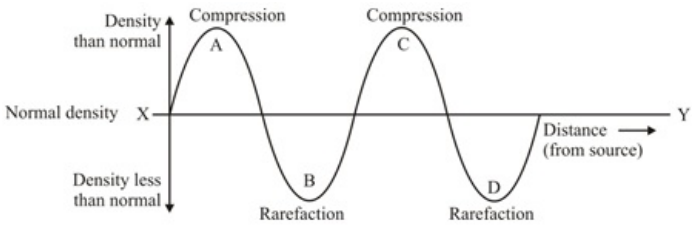
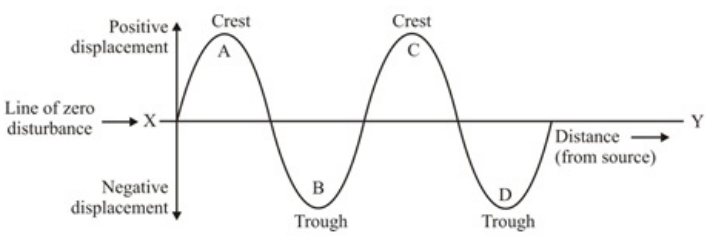


Diagram showing compression and rarefaction

(b)



Graphical representation of longitudinal wave.



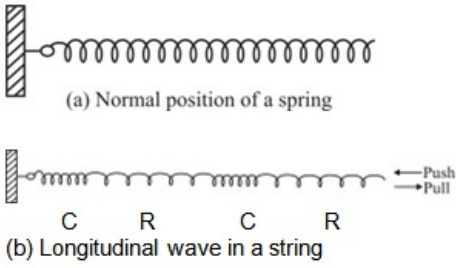
Graphical representation of transverse wave.

Q.43 Diagrammatically show how longitudinal wave travels along a slinky.

- In figure (a) the spring is in its normal position with one end fixed.

- When the loose end of the spring is moved to and fro regularly longitudinal waves are produced.

- There occurs alternatively compressions and rarefactions in the waves produced.



Q.44 Which type of waves is produced when:

(a) Wire of a guitar is plucked.

(b) A stone is dropped in a pond.

(a) When wire of a guitar is plucked, a longitudinal wave moves to and fro producing sound and the other wave, transverse wave is produced in the wire of the guitar as the particles vibrate perpendicular to the direction of the motion.

(b) When a stone is dropped in a pond, ripples are produced on the surface of the water. These ripples or water waves are transverse waves. This is as water molecules vibrate up and down perpendicular to the direction of the wave which is a character of transverse wave.

Q.45 Establish a relation between, speed, wavelength and frequency of wave.

Here, speed = v

Distance = wavelength = λ

Time period = T

Frequency = ν

Since,

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

$$v = \frac{\lambda}{T}$$

$$v = \lambda\left(\frac{1}{T}\right)$$

$$v = \lambda\nu \text{ (Since, } \lambda = 1/T)$$

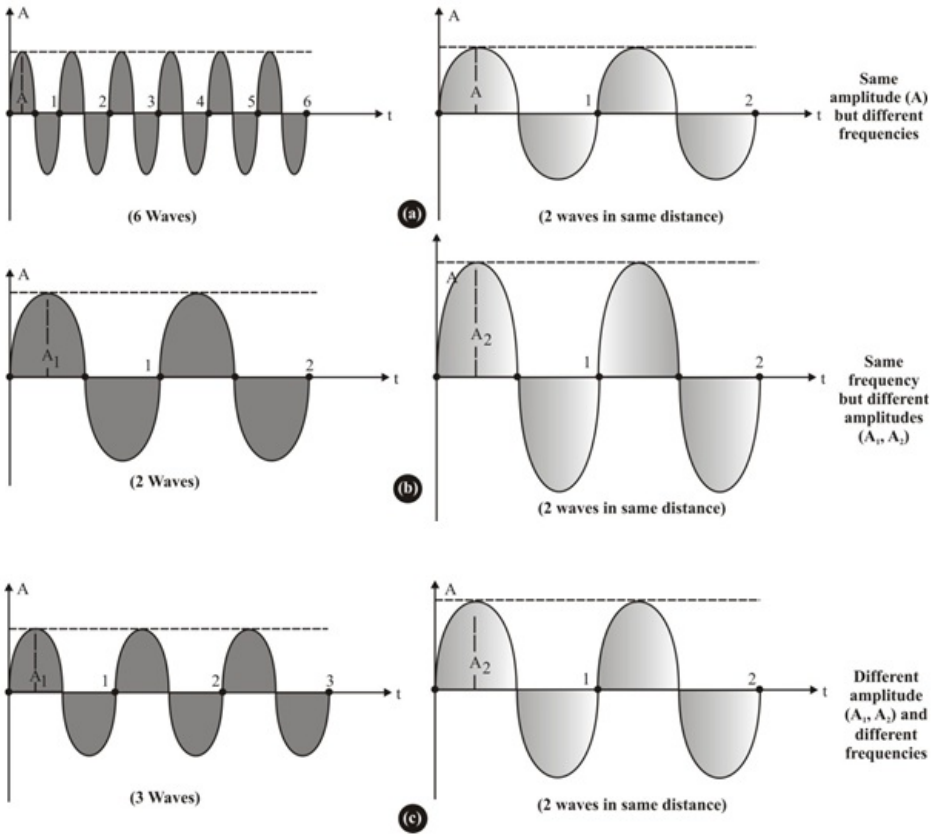
The relation between the three is given by, $v = \lambda\nu$.

Q.46 Graphically represent:

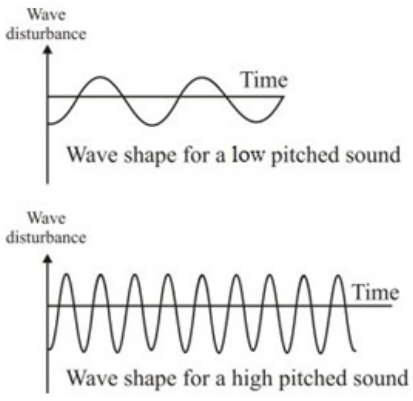
(i) Two sound waves with the same amplitude but different frequencies.

(ii) Two sound waves with the same frequency but different amplitudes.

(iii) Two sound waves with different amplitudes and also different wavelengths.



Q.47 Using labeled diagram show how low and high pitch sound are represented.



Q.48 What is wave number?

The no. of waves contained in unit length of the medium is known as wave number. It is the reciprocal of wavelength.

Q.49 Define sonic boom.

Sonic boom is the sound caused by objects like aircrafts, jet planes, etc. which travels at higher speed than that of sound.

The loud noise produced by high speed aircrafts generates very noisy sound waves known as shock waves in air. These shock waves have a great amount of energy which can even damage buildings and break glass.

A magnificent variation in air pressure created by the shock waves forms a tremendously loud sound Sonic boom.

Reflection of sound

Q.50 What is reverberation?

Reverberation is the persistence of sound after the source has stopped emitting sound.

This is due to multiple reflections of sound waves which mostly occur in big auditoriums, cinema halls, concert halls, etc.

Q.51 Which type of surfaces reflects the sound waves better?

The substances with hard surfaces reflect the sound waves better.

Q.52 How can reverberation be reduced?

Reverberation occurs due to the repeated reflection of the sound waves through the roof or ceiling, floor, walls of the hall or auditorium. To reduce this reflection, the absorption of the sound energy should be enhanced.

This can be achieved by following ways:

(i) False Ceiling: ceiling could be replaced by false ceiling made of sound absorbing material.

(ii) Floor: carpets could be placed on the floor.

(iii) Walls: the walls could be covered with some sound absorbing materials like, glass wool. In addition furniture is implanted in the room with curtains on the windows and doors.

Q.53 A certain amount of reverberation is desirable for speeches but the reverberation time should be short. Give reason.

Reverberation is necessary to some limit as this enhances the quality of the speech or music played in the hall.

The time till which the reverberation persists until it becomes indistinct is known as reverberation time.

In an auditorium or a hall, the reverberation time should be so adjusted that the speech could be heard clearly and distinctly. If the reverberation time is increased then the multiple echoes produced interferes with the original sound. As a result, the sound would not be able to hear clearly and distinctly.

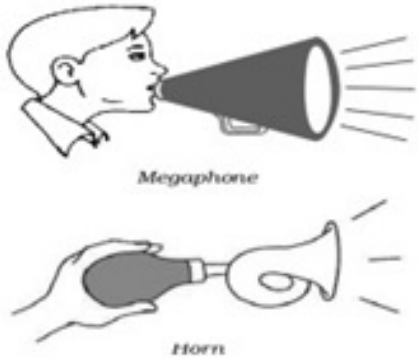
Q.54 Name one natural phenomenon caused by reflection of sound.

Thunder produced during lightning is a natural phenomenon caused by reflection of sound.

Q.55 Name any three practical applications of reflection of sound waves with the help of diagram.

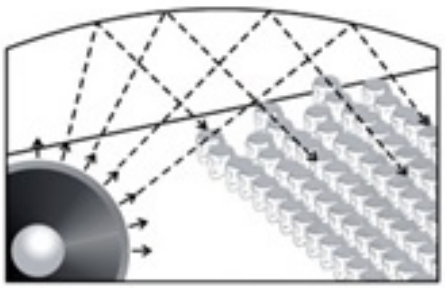
The three application of reflection of sound waves are:

Megaphone: The conical shape of megaphone helps in amplifying and directing the sound towards one direction through multiple reflections.



Stethoscope: It's an instrument used by the doctor to listen the sound produced by heart and lung in human body.

Sound board: It is a concave board used in auditoriums, cinema halls to spread the sound produced by the speaker evenly in the hall.



Q.56 Explain why?

(a) Flash and thunder are produced simultaneously. But thunder is heard a few seconds after the flash is seen.

(b) An echo is heard faster on a hot day than on a cold day.

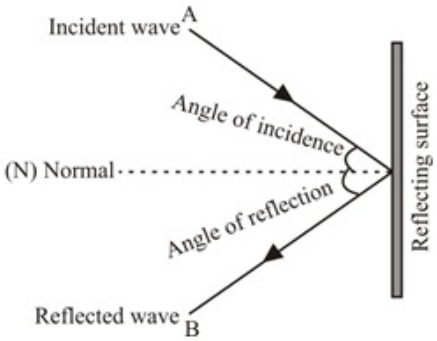
(a) Even though thunder and lightning are produced simultaneously, thunder is heard a few seconds after the flash of lightning is seen.

This is so as the velocity of light($3\ 10^8$ m/s) is much greater than the velocity of sound (340 m/s). Therefore light travels much faster than the sound.

(b) The speed of sound is greater in hot days as with the increase in temperature the speed of sound also increases. Therefore, an echo is heard faster on a hot day.

Q.57 Sound waves follow the same laws of reflection as light waves. State the laws of reflection of sound.

The sound wave and light waves follow the similar laws of reflection.



The Two laws of reflection of sound are:

1. First law: The angle of incidence (i) is always equal to the angle of reflection(r).

i = r

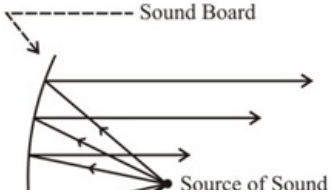
2. Second law: The incident sound wave, the reflected sound wave and the normal at the point of incidence, all lie in the same plane.

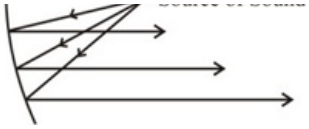
Q.58 How does a sound board work?

In big concert halls, conference halls, auditoriums etc the sound is absorbed by the ceilings, floor, walls, curtains, seats, etc. due to this the speech could not be easily heard by the crowd.

To overcome this sound board is being placed behind the speaker on the stage. This is a concave board which reflects the sound wave produced by the speaker standing on the focus of the soundboard. The reflected waves are directed towards the audience with even distribution in the hall.

The principle behind the sound board is multiple reflection of sound.





Q.59 (a) After a snowfall, why does it is quietness all around?

(b) Why do empty rooms do sound echoing?

(a) The snow absorbs sound with little reflection of sound. Therefore, the surroundings becomes quite after the snowfall.

(b) In an empty room there is very less absorption of the sound as there is no furniture or other material to absorb the sound. Therefore, the reflection dies out more slowly and sound seems to be hollow and echoing.

Q.60 What is an echo?

Echo is the recurring sound produced when the sound waves are reflected by an obstacle.

Q.61 Illustrate the conditions required to hear an echo.

- The minimum distance of the reflecting surface from the source should be 17.2 metres at a temperature of 20^{o}in air.
- The minimum time lag between the original sound and the reflected sound should be 0.1 second or 1/10 th of a sound.

Q.62 Why do auditoriums have:

(a) Curved roofs?

(b) Curtains, carpets and false ceilings?

(a) The ceilings of an auditorium are curved so that the sound produced reaches all corners of thehall by reflection from the curved surface. This enables the audience sitting in the hall at any place clear voice of the speaker. Principle behind this is ‘reflection of sound waves’.

(b) In big halls, sound is sustained in the hall due to repeated reflections from the walls, ceilings and floor of the hall. This is known as reverberation. A small reverberation is preferred but if it is increased the sound becomes blurred, and could not be easily audible. For removing this unnecessary reverberation there are certain substances like curtains, carpets and false ceilings used to absorb sound as a result reverberation is decreased. This is because the soft and porous materials are good absorbers and bad reflectors of sound.

Q.63 State reason:

(a) Bats cannot see, then how do they fly in dark and even catch their Prey.

(b) There are Moths of certain families which are able to escape capture from the bat.

(a) Bats produce high frequency squeaks in the direction they fly. The reflected ultrasonic waves are then heard back by them after striking their prey. By this process the position of an obstacle or a prey is judged. So the bat prevents collapsing with the obstacle, on the other hand eats up the prey.

(b) There are certain families of moth which can hear the squeaks produced by the nearby flying bat and could easily escape from being captured.

Q.64 When there are some natural calamities to be occurred then some animals escape from the site, before the calamities had happened.

There are some animals like dog, elephant, etc. which could hear the low frequency sound waves known as infrasound. These sounds cannot be heard by humans as it low frequency sound less than 20 Hz. As earthquakes produce low- frequency infrasound before the main shock waves begin. Now these sounds can be heard by these animals and they get alert and escape from the site much before.

Q.65 Which of the two have shorter wavelength: Infrasonic or ultrasonic waves?

Ultrasonic waves have shorter wavelength than the infrasonic waves. This is so as ultrasonic waves have greater frequencies than infrasonic waves and frequency of a wave is inversely proportional to the wavelength.

Application of Ultrasound

Q.66 (a) Write three main properties of ultrasound.

(b) Enlist four medical uses of ultrasound.

(a) Properties of Ultrasound:

- Longitudinal waves of frequencies lie above 20 kHz.
- Humans cannot detect this range of sound but some animals like dog, bat, etc. can.
- It has greater penetrating power so has a wide application in industries and medical purposes.

(b) Medical uses of ultra sound:

- Monitoring fetus inside the mother during pregnancy.
- Medical imaging of internal organs to check their size, structure and physiological functioning in humans.
- Breaking kidney stones into reduced sizes to flush out in the urine.
- Can be used in the neuralgic and rheumatic pains.

Q.67 Name one application of a sound wave having a frequency of 30 kHz.

Ultrasonic waves are sound waves having a frequency more than 20 kHz (even 30 kHz).

Ultrasonic waves are used in cleaning instruments and electronic devices.

Q.68 Explain how ultrasound is used to clean objects used in the industries.

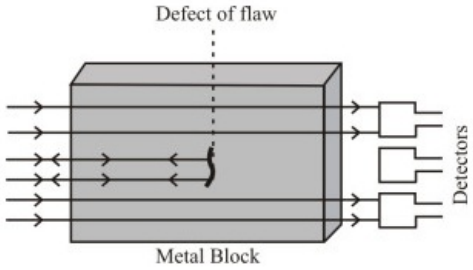
In industries, objects like spiral tubes, electronic component are used which are not easily reachable. Cleaning of these substances is quite hard so ultra sound waves are used to clean them. The objects need to be cleaned are first put in the cleaning solution and then ultrasonic waves are passed through it. Due to high frequency of ultrasonic waves there sets motion in the solution and the dirt particles attached to the objects loosen up and detach and clean the objects.

Q.69 Describe one application of ultrasound or ultrasonic waves in industry.

In industries, the large metal blocks used for the construction of bridges, buildings are checked before use.

Ultrasound waves are used to detect any fault present in a block of metal by using the principle, ‘reflection of sound’. This is a technique in which flaws in a block can be detected without being damaging.

Working-The sound waves are made to pass through one side of the metal block. The detectors are placed on the other side which detects the transmitted waves. If there is any flaw or defect like crack or hole, etc. inside the block then ultrasound gets reflected back and does not reach the detector.



Q.70 Why is dog considered most suitable by the police for detective purposes?

Certain animals like dogs, bats , dolphins , porpoises ,rats, etc can hear ultrasound waves which cannot be heard by humans. As dogs can hear ultrasonic sound waves of frequencies upto 50,000 Hz they are used by the police for detecting purposes.

Q.71 Can dolphin detect ultrasonic waves?

There are certain animals like dolphins, bats, porpoises, etc which can even produce ultrasonic waves on addition with hearing the waves. So, dolphin can detect ultrasonic waves.

Q.72 Define the terms:

(a) Ultrasound scanner

(b) Ultrasonography

(c) Electrocardiography

(a) Ultrasound scanner is a device used in ultrasonography. Using the reflected ultrasound wave it makes a photo of internal organs of the body. This is used to check the size, structure and physiological functioning of different organs of human body like liver, kidney, uterus, etc. It is also used to monitor the development of the fetus inside the mother.

(b) Ultrasonography is the technique used to take pictures of internal organs by the reflection of ultrasonic waves.

(c) Echocardiography is used to observe the function of heart through ultrasonic waves.

Q.73 What is the full form of SONAR?

'SOund Navigation And Ranging' is the full form of SONAR. This is a gear used to find the depth of the sea, to locate underwater objects like shoals of fish, icebergs, submarines of the enemies, etc.

Q.74 What is echo- ranging or sound ranging? State any one application of this technique.

The technique of finding the distance of an object with the concept behind as Echois called echo-ranging or sound ranging. Under this technique, the time taken by the echo to return back is used in finding the positions of substances.

The depth of the sea bed can be determined by this technique.

Q.75 Why are ultrasonic waves used in SONAR?

- These waves are high frequency and very short wavelength so can easily penetrate in seawater to locate the objects beneath the water while audible range of sound cannot be too penetrative.

- These waves cannot be misinterpreted by the sounds produced by ships or engine as this rangeof sound could not be heard by the humans.

Q.76 Explain the use and working of SONAR

SONAR is a device which uses ultrasonic waves to detect the depth of the sea, underwater substances like shoals of fish, submarines, etc.

Instrument : SONAR consists of:

(i) A transmitter for emitting ultrasonic waves and

(ii) A receiver for receiving reflected ultrasonic waves.

Working:

Transmitter emits ultrasonic waves which travel through water and gets reflected by the object in the path. After getting reflected these waves are detected up by the receiver. The receiver converts the reflected ultrasonic waves into electrical signals and records them.

Let t = time interval between the transmission and reception of the reflected ultrasound waves,

v = speed of sound under sea water.

d = distance of the object that reflected the ultrasound from the SONAR.

Total distance travelled by the ultrasonicwaves = 2 d (from the figure)

As distance = speed × time,

2 d = v × t

$$d = \frac{vt}{2}$$

Therefore, the distance of the object from the ship can be calculated from the above formula.

Use:

(i) Determine depth of the sea.

(ii) Trace underwater hills, icebergs, submarines and sunken ships.

(iii) Helps in communication between ships.

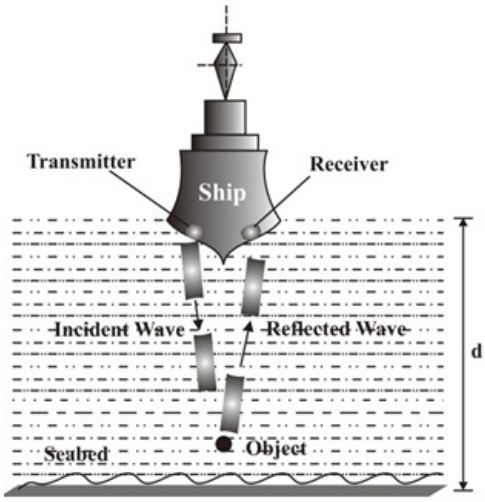


Figure showing the working of SONAR

Human ear

Q.77 What is persistence of hearing?

The time period till which the sensation of sound persists in our brain i.e. 0.1 second is known as persistence of hearing.

Q.78 What is the range of frequency which is audible to a average human?

The sound frequency ranging from 20 Hz to 20,000 Hz is audible to human. But, the children below 5 years of age can hear frequencies upto 25,000 Hz.

Q.79 Why does sound wave also known as Pressure wave?

As sound wave consists of an alternating pattern of high pressure (compressions) and low pressure (rarefactions) regions travelling through the medium, it is known as a pressure wave.

Q.80 How does the ear drum vibrates?

Sound wave is a longitudinal wave i.e. the particles of the medium vibrate to and fro parallel to the direction of wave. Through this there generates a low pressure and high pressure areas alternately known as rarefaction and compression respectively. When this sound wave of different pressure reaches the ear drum, the low pressure region or the rarefaction pulls the ear drum outward whereas the high pressure region or compression pushes the ear drum inwards. This impinges by alternate regions on the drum sets the ear drum in vibratory motion.

Q.81 Write a short note on Human ear.

Definition: Ear in humans is the sense organs which helps them to hear sound. It converts pressure variations in air of audible frequencies into electric signals which travel to brain through the auditory nerve.

Structure of ear:

(a) Outer part –

- Pinna collects sound waves from surroundings.
- Ear canal acts as long passage.
- Ear drum (tympanum) is present at the end of ear canal which is a circular and elastic membrane.

(b) Middle part –It consist of three bones, hammer, anvil and stirrup,

(c) Inner Part –It has a coiled tube, a cochlea which is filled with liquid containing nerve cells that are sensitive to sound.

Working:

- Pinna collects sound waves from the surroundings and made to fall on the ear drum, after which the eardrum starts vibrating back and forth quickly due to compression and rarefaction.
- These vibrations are then amplified many times by three bones in the middle ear.
- These vibrations are then passed through the liquid in cochlea which begins to vibrate and the pressure variations are turned into electric signals.
- These electric signals are carried by auditory nerve to brain. The brain interprets them as sound and humans get the sensation of hearing.

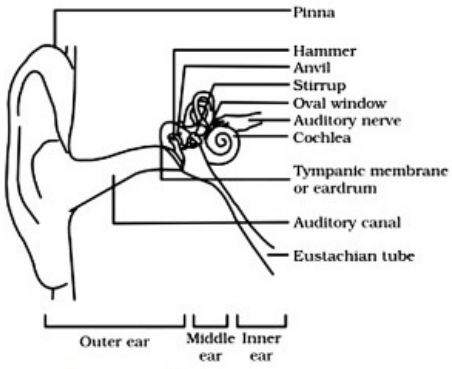


Diagram of Human ear

Q.82 In the old age people lost their hearing ability. Which device can be useful for them to support them hearing.

People which have problem in hearing, or which hear hard are given hearing aid for solving the problem. This is an electronic, battery operated device. It consists of a microphone and a speaker. The microphone converts the sound into electric signals which are then amplified by the amplifier. Now, these amplified signals are directed to the speaker where they are again converted to sound. This sound can now be heard by the person distinctly and clearly.

Numericals :

Q.1 Calculate the time taken by a sound wave to travel 1.5 km, when its frequency and wavelength are 2000 Hz and 0.35 m respectively.

Given,

Distance, s = 1.5 km = 1500 m

Time =?

Speed of sound, v =?

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

For speed

Frequency,v = 2000Hz

Wavelength, λ = 35 cm

$$v = \nu\lambda$$

= 2000 × 0.35 = 700 m/s.

$$\text{Therefore, } Time = \frac{Distance}{Speed}$$

$$= \frac{1500}{700} = 2.15 \text{ second}$$

Q.2 In a concert a pianist played some music on piano. Compare the Two Note A and B played when the speed of sound is 340 m/s and their wavelengths are 1.5 m and 1.33 m respectively.

Given,
Speed of sound, v= 340 m/s

Wavelength of Note A, λ_A = 1.5 m

Wavelength of Note B, λ_B = 1.33 m

Frequency of Note A, ν_A =?

Frequency of Note B, ν_B =?

$$Frequency\ of\ the\ sound\ wave, \nu = \frac{v}{\lambda}$$

$$\nu_A = \frac{v}{\lambda_A} = \frac{340}{1.5} = 226.66Hz$$

$$\nu_B = \frac{v}{\lambda_B} = \frac{340}{1.33} = 255.63Hz$$

The frequency of Note B is more than frequency of Note A.

Q.3 Ocean waves have speed 15 m/s and time period 0.01. Find out the wavelength and the distance between the adjacent crest and the trough.

$$\text{Wavelength } (\lambda) = Time\ period(T) \times Speed\ of\ sound(v) = 15 \times 0.01 = 0.15m$$

Distance between crest and trough is half the wavelength = $\lambda/2 = 0.075m.$

Q.4 Calculate the frequency at which the boat rocks when waves of wavelength 100 m travelling at a speed of 20 m/s strikes it.

Given,

Wavelength, λ = 100 m,

Speed of sound, v = 20 m/s,

Frequency, ν =?

$$\nu = \frac{v}{\lambda} = \frac{20m/s}{100m} = 0.2\ Hz$$

Q.5 In a cancer treatment hospital an ultrasound scanner is used to locate tumors in a tissue. It operates at frequency of 4.2 MHz. Calculate the wavelength of sound in a tissue? (Speed of sound in the tissue is 1.7 km/s)

Speed of sound, v = 1.7 km/s,

Frequency of wave, ν = 4.2 MHz = 4.2×10^6 Hz

$$\text{Wavelength, } \lambda = \frac{v}{\nu} = \frac{1.7km/s}{4.2\times10^6/s} = \frac{1700m/s}{4.2\times10^6/s} = 4 \times 10^{-4}m$$

Q.6 Calculate the frequency of sound, where source of sound produces 500 compressions and 500 rarefactions in air in 25 seconds.

Since, a compression and rarefaction combines to form a wave therefore no. waves = 500.

$$\text{Frequency} = \frac{No.\ of\ waves}{Time} = \frac{500}{25} = 20Hz.$$

Q.7 What will be the wavelength and velocity of the wave produced when a stone is thrown in a pond. After the fall, stone produces 12 full ripples in 1 second in water. Also, the distance between a crest and a trough is 10 cm.

Given,

Frequency = $\frac{No.\ of\ waves}{Time} = \frac{12}{1} = 12$

Distance between the crest and next trough, λ /2 = 10 cm

Therefore, wavelength, λ = 20 cm = 0.20 m

Since, velocity = frequency × wavelength

Therefore, velocity = 12 × 0.20 = 2.40 m/s

Q.8 A kid watching Dusshera celebration from a distance watches the statue of Ravana burn into flames and hears the explosion after 2 sec. If the speed of sound in air was 335 m/s what would be the distance of statue from the kid?

Given,

Speed of sound, v = 335 m/s

Time, t = 2 sec

Distance, d = v × t

= 335 × 2 = 670 m.

Q.9 Find the angle of incidence when 110^0 is the angle between incident wave and reflected wave.

Given,

$\angle i + \angle r = 110^\circ$

Since, $\angle i$ (angle of incidence) = $\angle r$ (angle of reflection)

$\Rightarrow 2\angle i = 110^\circ$

$\Rightarrow \angle i = \frac{110}{2} = 55^\circ$

The angle of incidence = 55°

Q.10 A boy standing on a tower of height 500 m drops a stone into a pond of water at the base of the tower. Calculate:

(a) Time taken by the stone to reach the pond.

(b) Time taken by the splash to be heard by the boy.

[Given, g = 10 ms^{-2} and speed of sound = 340 ms^{-1}].

(a) Time taken by the stone to reach the pond.

According to the equation of motion-

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

Where, s = height of the tower = 500m

u = Initial velocity of stone = 0

t = time taken by the stone to reach the base of the tower =?

g = acceleration due to gravity = 10 m/s^2

By putting the values in equation,

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

$$500 = 5\ t^2$$

$$t = \sqrt{100} = 10 \text{ seconds.}$$

(b) Time taken by the splash to be heard by the boy = Time taken by the stone to reach the pond + time taken by the splash to reach at the top of the tower.

Time taken by the splash to reach to the top of the tower:

$$t^{!} = \frac{Distance\ travelled}{Speed}$$

$$\frac{500}{340} = 1.47 \text{ seconds}$$

Therefore,

Time taken by the splash to be heard by the boy = 10 + 1.47 seconds = 11.47 seconds

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Q.11 Calculate the distance between a source of sound and the wall when echo returns from the surface of the wall in 1.5s. (Speed of sound= 334 m/s)

Given,

Time taken to receive echo= 1.5 s

Speed of sound= 334 m/s

Since, echo travels twice the distance between the source and the object.

Therefore,

$$Distance = \frac{Speed\ of\ sound \times Time\ taken\ to\ receive\ echo}{2}$$

$$Distance = \frac{334 \times 1.5}{2} = 250.5\ m$$

Q.12 Ranvijay is standing at a distance of 51m from a wall. He fires a gun. Find out the time after which an echo is heard. (Speed of sound in air = 340 m/s)

Given,

Distance, d = 51 m,

Speed of sound in air, v = 340 m/s.

Since,

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

$$\text{Therefore, Time} = \frac{Distance}{Speed}$$

$$\text{For echo, } \frac{Distance \times 2}{Time}$$

$$t = \frac{2d}{v} = \frac{2 \times 51}{340} = 0.3\ s$$

The time after which echo is heard by Ranvijay is 0.3 second.

Q.13 A girl standing in the middle of a big square field explodes a cracker. She heard an echo 0.4 later when there is a tall building on one side of the field. What is the size of the field? (Given, Speed of sound in air is 330 m/s).

Given,

Speed of the sound, v = 330 m/s

Time taken in hearing the echo, t = 0.4 second

Distance travelled by the sound, d = v × t

= 330 × 0.4 = 132 m.

The distance travelled by the sound is twice of the original distance as in echo produced sound need to travel two times.

Therefore, distance = 132/2 = 66 m.

Side of the square field = twice the distance between the girl and building

= 132 m

Size of square field = side × side

= 132 × 132 = 17424 m^2

The size of square field is 17424 m^2.

Q.14 A Ship emits ultrasound waves from SONAR fitted down. This wave returns from an underwater iceberg in 1.02 seconds. Calculate the distance of iceberg from the ship when the speed of sound in sea water is 1531 m/s.

Given,

Time taken by the ultrasonic wave to return back to ship after reflection from the iceberg, t = 1.02 seconds

Speed of sound in sea water = 1531 m/s

Total distance travelled by the ultrasonic waves = 2 × Distance between the ship and the iceberg, d

Distance = Speed × Time

2 d = 1531 × 1.02

$$\therefore \text{ d} = \frac{1531 \times 1.02}{2} = 780.81\text{m}$$

Therefore, the distance between the ship and iceberg is 780.81 m.

Value Based Questions: -

Q.1 Rahul went to Russia for holidays there he watched an opera performance in Novosibirsk Opera and Ballet Theatre, in Novosibirsk. He admired the architecture and furnishing of the auditorium. There were curved ceiling, swags, curtains and cushions positioned all around. The floor was also carpeted. After the performance was over all were taken to watch the auditorium. During that he noticed a sound board behind the stage. After watching all this he doubted whether all these things where just for increasing the beauty of the hall or also had a scientific reason.

On the basis of above passage answer the following questions:

(a) What could be the reason for placing of curtains, cushions and carpets in the opera house?

(b) Discuss the use of curved ceiling and sound board?

(c) Which values are possessed by Rahul?

(a) To avoid reverberation (multiple reflection of sound) in the auditoriums, materials which can absorb sound energy is used.

(b) Sound boards and curved ceilings are present in the auditorium to generate maximum reflections to facilitate the sound in every corner of the auditorium.

(c) Rahul has a keen interest in art but also has scientific approach towards the happenings around.

Q.2 Shikha went to a Himachal Pradesh to meet her friend Rita. She was astonished to watch high mountain ranges, waterfalls, and the terrific greenery all around during her journey. After reaching their Rita took her to a peak and asked her to call upon her name at the top of her voice. By doing this Shikha could hear the echoes of her own voice which filled her with joy. After returning to Rita's home, she tried to hear her echo in the same way in the room but failed. She searched about this on internet and got answers to her questions and went to bed.

(a) What is Echo?

(b) Why Shikha could not heard the echo at Rita's room?

(c) Which qualities do Shikha have?

(a) Echo is a phenomenon which produces recurrences of sound from a source by reflections through the obstacle.

(b) For hearing an echo, there should be some requirements to be fulfilled like the distance between the

source of sound and obstacle should be minimum 17.2m. Also most of the sound is being absorbed by the furnishing in the room.

(c) She is curious to learn about the natural phenomenon for which she makes use of latest technology.

Q.3 Vartika was conceiving for the first time. Her mother -in -law did not wanted the first child of her to be a girl. Vartika's mother -in -law took her to a gynecologist for ultrasonography to determine whether the child is a boy or a girl. Doctor denied telling the gender of the child.

(i) Define ultrasonography? Why is ultrasonography used in pregnancy?

(ii) Which principle is involved behind its working?

(iii) Why did Doctor denied the in telling the gender of the child?

(i) Ultrasonography is a technique in which ultra sound waves are used for imaging of internal organs of body, like heart, uterus, etc. to detect any dis functioning in the organ. It is used in the diagnosis of congenital defects and abnormalities which could be present in the child.

(ii) Reflection of sound.

(iii) To reveal the gender of a child before birth is against the law. Under this law the parent of the child and the doctor are charged with a fine and also could be put in jail.

Q.4 On D.D. channel Akhil was watching a documentary based on usage of submarine in Indian navy. The navy officials were using a device to track down their enemies submarines present in the water at a distance of few kilometers from their ship. They also used this device for underwater communication and to avoid obstacles in the way.

(i) Which device are they using?

(ii) What is the principle used behind this device?

(iii)What are the other uses of this device?

(i) SONAR-Sound Navigation and Ranging.

(ii) Principle used reflection of ultrasonic sound waves.

(iii) SONAR can be used to trace the shoal of fish, a sunken submarine or ship, icebergs present in the sea or oceans.

Q.5 Jiya's sister is music lover, she used to listen songs the whole daylong. She likes to listen music at high intensity levels. Family members used to warn her for not being aware about her health as she sometimes has pain in her ears. But she ignores listening to her family. Continuous hearing of loud music can damage her hearing power. Damage to hearing ability depends on two factors: the sound intensity level (dB) and the exposure time. In general, at 90 dB, it takes 8 hours or less for the damage to receptor nerves to occur. Moreover, it is discovered that if the sound level is increased by 5 dB, the safe exposure limit is dropped to half.

From reference to the above passage, answer the following questions:

(a) What time would be safe to expose the ear to a sound of 95 dB and 105 dB respectively?

(b) What nature of Jiya's sister is being reflected in the passage?

(a) As it is found that by increasing the sound intensity by 5 dB from 90 dB then the time taken to damage the hearing power would decrease to half. Therefore the time for safe exposure of sound of intensity 95 dB would be half of 8 h which is less than 4h. Similarly, with sound Intensity level of 105 dB, which is 15 dB i.e., 3 times 5 dB above 90 dB, therefore will have $(1/2)^3$ of 8 h, i.e. 1h to damage the hearing power.

(b) Jiya's sister is ignorant about the incapacity to hear. She didn't take things seriously, which could lead her to a permanent loss of hearing.

Practice Questions

1 Mark Questions

Q.1 Give two practical applications of reflection of sound waves.

Q.2 What happens to speed of sound when it goes from solid to gaseous state?

Q.3 How are wavelength, speed and time period related for a sound wave?

Q.4 What is the nature of sound waves?

Q.5 What is the frequency of wave with time period 0.025 s?

Q.6 Give one example of transverse and longitudinal wave each.

Q.7 On what factor does the quality of the sound depend?

Q.8 What are infrasonic and ultrasonic sounds?

Q.9 A baby recognizes her mother by her voice. Name the characteristics of sound involved.

Q.10 The frequency of a source of sound is 100 Hz. How many times does it vibrate in a minute?

Q.11 How does speed of sound change with temperature of medium?

Q.12 Name the device which is used to measure intensity of earthquake.

Q.13 Why are sound waves called mechanical waves?

Q.14 Find the time period of oscillation if a body vibrates 150 times in a minute.

Q.15 Give two examples of electromagnetic waves.

Q.16 Give two examples of mechanical waves.

Q.17 Define amplitude and give its SI unit.

Q.18 How is frequency of wave related to its time period?

Q.19 If a source of sound produces 500 compressions and 500 rarefactions in air in 25 seconds, find the frequency of sound produced.

Q.20 What is the audible range of frequency in humans?

Q.21 How do bats locate their prey?

Q.22 How is ultrasound used in cleaning?

Q.23 Distinguish between tone and note of sound.

Q.24 Give the function of (a) ear drum (b) cochlear fluid in human ear.

Q.25 What is meant by quality of sound?

Q.26 Give significance of ultrasound in metal industry.

Q.27 Name any two animals which produce ultrasound .

Q.28 Why do we see streaks of lightning much before we hear the sound of thunder?

Q.29 How is noise different from music?

Q.30 Define reverberation.

Q.31 What do you mean by seismic waves?

Q.32 The following figures shows the wave shapes of two sounds of same frequency. Which of these is likely to represent the sound produced by a car-horn?

Q.33 Draw a diagram of transverse wave and label it.

Q.34 Draw a diagram of longitudinal wave and label it.

Q.35 Graphically distinguish between sounds of low pitch and high pitch.

Solutions

Q.1 Two practical applications of reflection of sound waves are -

(a) Megaphones or loud hailers are designed to send sound in a particular direction.

(b) Stethoscope are based on the principal of multiple reflection of sound within the stethoscope tube enabling the doctor to hear a patient's heartbeat.

2. When sound goes from solid to gaseous state it slows down.

3. Speed = Wavelength × Time Period

4. Sound waves are longitudinal waves which require a material medium to travel.

5. T = 0.025 s

Therefore, frequency
$\nu = \frac{1}{0.025}$ = 40 Hz

6. Transverse waves - light wave.

Longitudinal waves - sound wave.

7. The quality of sound depend on the frequency and its harmonics.

8. Sound below 20 Hz are called infrasonic and sounds above 20,000 Hz are called ultrasonic.

9. Quality or timbre

10. Frequency = 100 Hz = 100 vibrations/sec

Therefore , in minute no. of vibration =100 × 60 = 6000

11. The speed of sound increases with temperature.

12. Seismograph

13. Sound waves are called mechanical waves as they need a material medium to travel.

14. Time period
$T = \frac{Time}{No. of oscillation} = \frac{60}{150} = 0.4\,s$

15. X-rays, Gamma rays

16. Two examples are (i) Sound waves and (ii) Waves produced in a string.

17. Amplitude is the maximum displacement of a particle from its mean position, its unit is m.

18.
$\nu = 1/T$

19. 500 compressions are produced in 25 s.

Therefore in 1 sec, no. of compression =
$\frac{500}{25}$ = 20

Frequency =20 Hz

20. Audible range for human beings 20 Hz−20,000 Hz

21. Bats emit ultrasound. These are reflected by various obstacles and return to the bat's ear. The nature of reflection tells the bat where the obstacles or prey is and accordingly the bat is able to catch its prey.

22. Ultrasound are high frequency waves. Objects to be cleaned are placed in a cleansing solution and ultrasonic waves are passed. The continuous high frequency vibration cause the dust, grime etc. to detach from the object and can then be easily washed away.

23. Sound of single frequency is called tone whereas sound which is produced by mixture of several frequencies is called note.

24. (a)The eardrum is a membrane which vibrates when sound reaches it . It helps in amplifying sound by means of 3 small bones attached to it.

(b) The cochlear fluid is set into vibrations. There are tiny hair like structures in it which convert these vibrations into electrical impulses that are carried to the brain by the auditory nerve.

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25. Sound consists of a particular frequency and its multiple frequencies which are called harmonic or overtones. Sound is said to be of good quality if it contain a large number of harmonics.

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26. Ultrasound is used in metal industry to detect flaws in metals . The cracks and holes inside metal blocks reduce its strength. Ultrasound is passed through the metal and if there is a flaw , it is detected by the reflection of these sound waves.

Hence, ultrasound has a significant role to play in the metal industry as it ensures the strength of the material by detection of flaws.

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27. Animals producing ultrasound are : bats and porpoises.

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28. Thunder is heard after the flash of light is seen because sound and light travel at different speed. Light travels at the speed of about
$3 \times 10^8 m/s$ whereas sound travels at about 300 m/s.

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29. Sound which is pleasant to hear is called music. Noise is unpleasant to hear. A sound which is produced due to a mixture of frequencies is pleasant whereas noise has no periodicity and creates no recognized pitch or tone quality.

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30. The persistence of sound due to its repeated reflection is called reverberation.

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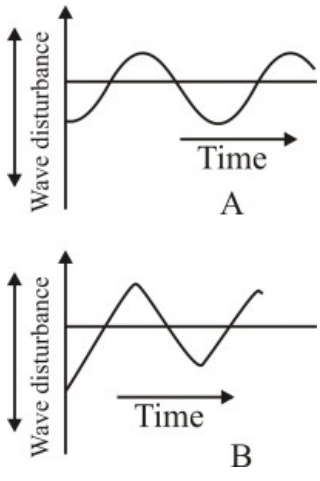
31. Seismic waves are produced on the earth's layer due to volcanic activity or earthquake. They are low frequency waves which travel through the ground.

32.



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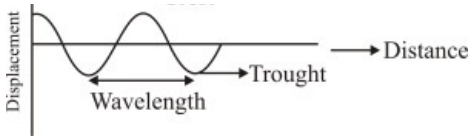

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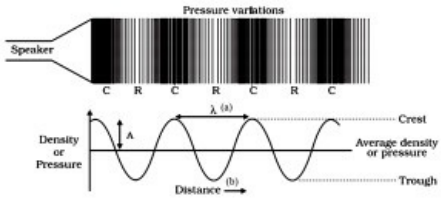
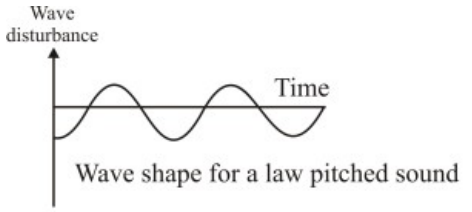
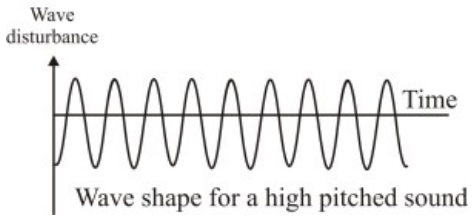


35. Low pitch sound High pitch sound :-





2 Marks Questions

Q.1 A sonar device on a submarine sends out a signal and receives an echo 5 seconds later. Calculate the speed of the sound in water if the distance of the object from the submarine is 3625 m.

Q.2 An echo is returned in 6 seconds. What is the distance of reflecting surface from source? Given that speed of sound is 342 m/s.

Q.3 (a) Sound is produced when your school bell is struck with a hammer. Why?
(b) Which characteristic of sound helps to identify your friend by his voice while sitting with others in a dark room?

Q.4 Give one difference between transverse and longitudinal wave. Give one example for each.

Q.5 Sound of explosions taking place on other planets is not heard by a person on the earth. Give reason.

Q.6 (a) Which wave property determines (i) Loudness, (ii) Pitch?

(b) How are wavelength and frequency related to speed of sound waves?

Q.7 What is echo ranging? State any one application of this technique.

Q.8 Three persons, A, B and C are made to hear a sound travelling through different media as given below:

Person	Medium
A	Iron Rod
B	Air
C	Water

Who will hear the sound first? and why?

Q.9 A hospital uses an ultrasonic scanner to locate tumors in a tissue. What is the wavelength of sound in a tissue in which the speed of sound is 1.7 km/s. The operating frequency of the scanner is 4.2 MHz

(MHz = 106 Hz).

Q.10 How are ultrasonic waves different from ordinary sound waves? State two applications of ultrasound.

Q.11 Distinguish between echo and reverberation.

Q.12 Aditi clapped her hands near a cliff and heard the echo after 4 seconds. What is the distance of the cliff from her if the speed of sound is taken as 346 m/s .

Q.13 When a sound is reflected from a distant object, an echo is produced and heard in a winter night. Now, if the distance between the reflecting surface and the source of sound production remains the same, will you hear the echo of the same sound on a summer day? Explain.

Q.14 What is meant by intensity of sound? How is it different from loudness?

Q.15 A sound wave has frequency of 3 kHz and a wavelength 45 cm. How long will it take to travel 1.8 km?

Q.16 Describe two uses of multiple reflections of sound.

Q.17 What is SONAR? Write two uses of SONAR technique?

Q.18 Distinguish between transverse waves and longitudinal waves.

Q.19 Differentiate between mechanical waves and electromagnetic waves.

Q.20 Give four properties of sound waves.

Q.21 We receive heat and light from the Sun, but don't hear the sound of explosions occurring on it. Why?

Q.22 Define amplitude of a wave. Hew does it help to explain loudness of sound produced?

Q.23 An observer stands between two distant cliffs and claps his hands. He receives echo after 2 s and 2.5 s respectively. If speed of sound is 330 m/s, find the distance between the cliffs ?

Q.24 How does speed of sound change with (a) temperature of medium (b) physical state of medium?

Q.25 Explain the working of SONAR ?

Q.26 The successive crest and trough of a wave 30 cm apart. Find the wavelength. Also, find the frequency of wave if 10 crests and 10 troughs are produced in 2 s.

Q.27 How does sonic boom occur?

Q.28 The string of a guitar is plucked. What type waves are produced in a) guitar (b) air?

Q.29 Find the distance between a surface and the source of sound, if speed of sound is 334 m/s and echo returns from the surface in 1.5 s.

Q.30 Define wavelength and relate it with frequency or sound and its velocity.

Q.31 Why can't we hear the sound of squeaks produced by bats?

Q.32 Differentiate between low and high pitch sound using neat and labelled diagram.

Q.33 Draw a neat labelled structure of human ear, depicting the auditory parts only.

Q.34 Draw a graph showing a person with soft and loud voice.

Q.35 Prove that sound waves are mechanical waves with the help of an experiment.

Q.36 (a) What is meant by 'Compression' and ` Rarefaction' of a longitudinal wave?

(b) Give well labelled graphical representation of a longitudinal wave.

Solutions

1. Speed =Total distance travelled / Total time

Here object distance = 3625 m

Therefore total distance travelled by sound = 3625 × 2 m

Time = 5 s

$$\text{Speed} = \frac{3625 \times 2}{5} = 1450\, m/s$$

2. Echo takes 6 sec to return.

Speed of sound = 342 m/s

Therefore $d = \frac{v \times t}{2} = \frac{342 \times 6}{2} = 1026\, m$

---

3. (a) When the bell is struck with a hammer, the bell starts vibrating . These vibrations set the air near it to vibrate which spread as longitudinal waves in all direction. These vibrations are sound waves.
(b) The quality or timbre of sound helps us to identify our friends.

---

4. In transverse waves particles move perpendicular to the direction of propagation eg. light waves.

In longitudinal waves the particles vibrate along the direction of propagation, eg. sound wave.

---

5. Sound of explosions taking place on other planets is not heard on earth because sound cannot travel in vacuum.

---

6. (a) 1) Loudness - Amplitude (2) pitch - Frequency

(b) speed = wavelength × frequency

---

7. Echo ranging is the technique used to determine the distance and location of object by using ultrasound. The time interval between transmission and reception of sound is noted and distance can be calculated by the formula $d = \frac{v \times t}{2}$ where v is the velocity of sound and t is time for echo to be heard. It is used in SONAR to locate depth of the sea and other underwater objects.

---

8. A will hear the sound first because sound travels fastest in solids.

---

9. Speed of sound 1.7 km/s = $1.7 \times 10^3\, m/s$

Frequency $= 4.2\, MHz = 4.2 \times 10^6\, Hz$

Wavelength $\lambda = \frac{speed}{frequency} = \frac{1.7 \times 10^3}{4.2 \times 10^6} = 4.047 \times 10^{-3}\, m$

---

10. Ultrasonic waves have frequency above 20,000 Hz. They are not audible to human beings . They are able to travel in well defined paths even in the presence of obstacles as their wavelength is very small.

Application -

(i) Used to clean parts of equipment located in hard to reach places.

(ii) Used to detect cracks and flaws in metal blocks.

11. When sound reflected from object returns to the listener and can be heard clearly, it is called an echo. It can be heard only if the reflected sound is heard after 0.1 s. In time less than 0.1 s, the listener is unable to identify the sound and its reflection. Sound created in a big hall is reflected continuously from its wall. This repeated reflection causes persistence of sound for some time. This is called reverberation.

12. Time of echo = 4 s

Speed of sound = 346 m/s

Distance of cliff $= \frac{speed \times time}{2} = \frac{346 \times 4}{2} = 692\,m$

13. Time taken = Total distance velocity .

On a hotter day the velocity of sound is more. So reflection will reach in lesser time. If the time taken by reflection is less than 0.1 sec. Echo will not be heard.

14. Intensity is the amount of sound energy passing per second per unit area. It is proportional to square of amplitude.

Loudness and intensity both depend upon the amplitude of sound. But loudness is the physiological response of our ears to a particular frequency. Our ears are more sensitive to some frequencies as compared to others.

15. Frequency ν = 3 KHz = 3000 Hz

Wavelength λ = 45 cm = 0.45 m

Distance d = 1.8 km = 1800 m

V = νλ = 3000 × 0.45 m/s

Time for wave $= \frac{d}{v} = \frac{1800}{3000 \times 0.45} = 1.33\,s$

16. Two uses of multiple reflection of sound are -

(i) Musical instruments like trumpets and Shehnais are designed in such a way that sound moves with the tube of the instrument by multiple reflection and comes out from the conical opening at its end. The sound waves are thus directed in the direction of audience in front.

(ii) In stethoscopes the sound of the patients heart beat reaches the doctors ear by multiple reflection of sound within the stethoscope tube.

17. The acronym SONAR stands for sound , navigation and ranging. It is a technique used to determine depth of sea end locate underwater objects like hills, valleys, sunken ships etc.

18. Transverse wave

1. The particles moves or vibrate about their mean position in a direction perpendicular to the direction of propagation

2. It travels in the form of crests and troughs.

3. Light waves are transverse waves and may travel in vacuum.

Longitudinal waves

1. The particles vibrate about their mean position in a direction parallel to the direction of propagation

2. It travels in the form of compression and rarefaction.

3. Sound waves are longitudinal waves and can be produced only in a material medium.

---

19. Mechanical waves are waves which need a material medium to travel . They may be transverse or longitudinal.

Electromagnetic waves do not require a material medium .They can travel in vacuum. They are always transverse waves.

---

20. Properties of sound -

(i) It is a mechanical wave.

(ii) It travels fastest in solids.

(iii) The speed of sound depends on temperature

(iv) It travels as longitudinal wave.

---

21. Sound cannot travel in vacuum. So explosions in sun cannot be heard on earth. Light travels to earth since it can travel in vacuum.

---

22. In a wave, the particles vibrate about their mean position. The maximum displacement of the particle about its mean position is called amplitude. Larger is the amplitude , greater is the energy carried by the wave.

Loudness depends on amplitude, A loud sound will have greater amplitude as compared to a soft sound.

---

23. Time of echo = 2 s and 2.5 s

speed of sound = 330 m/s

Distance of first cliff $= \frac{v \times t}{2} = \frac{330 \times 2}{2} = 330\ m$

Distance of second cliff $= \frac{v \times t}{2} = \frac{330 \times 2.5}{2} = 412.5\ m$

Distance between cliffs = 300 + 412.5 = 712.5 m

---

24. (a) With increase in temperature, speed of sound increases.

(b) Denser is the medium , greater is the speed of sound . Hence it is maximum in solid and minimum in gases.

---

25. SONAR stand for Sound, Navigation And Ranging. It is a device used to measure distance, direction and speed of underwater objects. It has a transmitter and detector near its base. The transmitter transmits ultrasonic signals which get reflected by various underwater objects. These are received by the detector which can convert these waves into appropriate electrical signals and give us the required information.

---

26. Distance between crest and trough = 30 cm.

Distance between crest and crest = 60 cm

Hence wavelength λ = 60 cm = 0.60 m

In 2 sec, 10 crest or 10 waves are formed

Therefore in 1 sec. 5 crest or waves are formed

Hence frequency = 5 Hz

---

27. When any object travels at a speed greater than sound, shock waves are produced which travel at the speed of sound . The sound produced is called sonic boom , which sounds as an explosion.

---

28. In the guitar transverse waves are produced, whereas in air longitudinal waves are produced.

---

29. Speed of sound = 334 m/s

Time of Echo = 1.5 sec

Distance between surface and source $= \frac{v \times t}{2} = \frac{334 \times 1.5}{2} = 250.5\ m$

---

30. Wavelength is the distance travelled between consecutive compressions or rarefactions.

Velocity $= \frac{dis\tan ce}{time}$

If the distance travelled = 1 wave length=λ

and time to travel = Time period = T

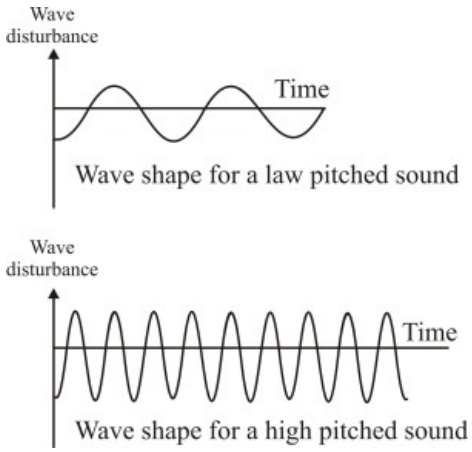
$$V = \frac{\lambda}{T} = \lambda \times \nu$$

where $\nu = \frac{1}{T}$

---

31. Since the sound produced by bats is of frequency greater than 20,000 Hz. Which is not audible to the human ear, we cannot hear the squeaks.

32.



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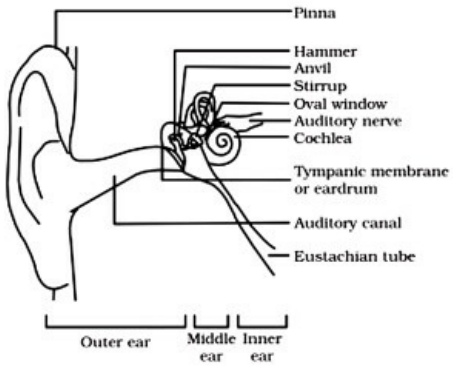
33. Human Ear : -



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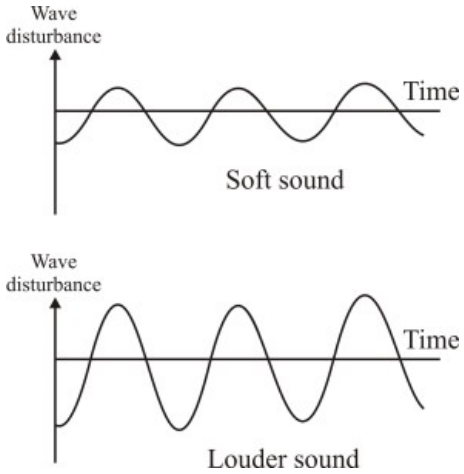

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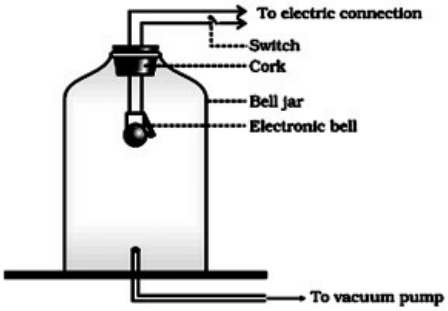
35. Take an electric bell and an airtight glass bell jar. The electric bell is suspended inside the airtight bell jar. The bell jar is connected to a vacuum pump, as shown in Fig. If you press the switch you will be able to hear the bell. Now start the vacuum pump. When the air in the jar is pumped out gradually, the sound becomes fainter, although the same current is passing through the bell. After some time when less air is left inside the bell jar you will hear a very feeble sound. When all the air is removed, no sound can be heard. This shows that sound require a material medium to travel.



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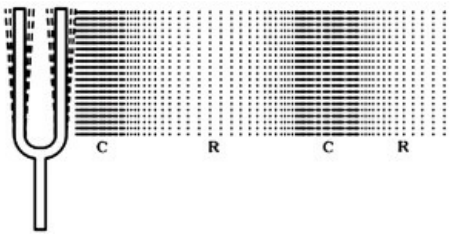
36. (a) Compression : When air vibrates, it is pushed away by the vibrating object . In that region air particles come very close to each other. This is called compression.

Rarefaction : When the air particles are compressed in a region they have a tendency to push the particles is the forward and backward direction simultaneously. Particles move away from that region. Now there are less air particles then normal . This is called rarefaction.



3 Marks Questions

Q.1 A construction worker's helmet slips and falls when he is 78.4 m above the ground. He hears the sound of the helmet hitting the ground 4.23 seconds after it slipped. Find the speed of sound on air.

Q.2 Define the term 'tone'. A person is listening to a sound of 500 Hz sitting at a distance of 450 m from the source of the sound. What is the time interval between successive compressions reaching his ears from the source.

Q.3 What does SONAR stand for? Name its two main parts. List two uses of SONAR technique.

Q.4 (a) State a condition for an echo to be heard.

(b) Bats cannot see, then how do they catch their Prey.

Q.5 A sound wave travels at a speed of 339 m/s if the wavelength is 1.2 cm, what is the frequency of the wave.

Q.6 Write three medicinal applications of ultrasound.

Q.7 (a) The sound of an explosion on the surface of lake is heard by a boatman 100 m away and a driver 100 m below the point of explosion. Of the two persons mentioned (boatman or driver) who would hear the sound first? And why?

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

Q.8 (a) What is audible range of the average human ear?

(b) Explain how ultrasound is used to clean spiral tubes and electronic components?

Q.9 (a) Why the stage of an auditorium has curved background curtains, carpets and false ceiling?

(b) The sound of a ringing bell inside a vacuum chamber cannot be heard. Why?

Q.10 Ocean waves of time period 0.01s have a speed of 15 m/s. Calculate the wavelength of these waves. Find the distance between the adjacent crest and the trough.

Q.11 State the relationship between frequency and time period of a wave. The wavelength of vibrations produced on the surface of water is 2 cm. If the wave velocity is 16 m/s, find its frequency and Time period.

Q.12 What is reverberation? Suggest two methods to reduce it in big halls.

Q.13 Why are sound waves called mechanical waves? Explain.

Q.14 A sound wave has a frequency of 2 kHz and a wavelength of 45 cm. It takes 4 s to travel. Calculate the distance it travels.

Q.15 A person produced a sound with a siren near a cliff and heard echoes after six seconds. Find the distance of the siren from the cliff if velocity of sound waves produced is 330 m/s?

Q.16 (a) Define frequency of a sound wave and give its SI unit.

(b) Why are the roof and walls of an auditorium/ hall generally covered with sound absorbent materials?

Q.17 What is ultrasound? What is its frequency? Give its uses.

Q.18 Define (a) pitch (b) quality (c) loudness of sound.

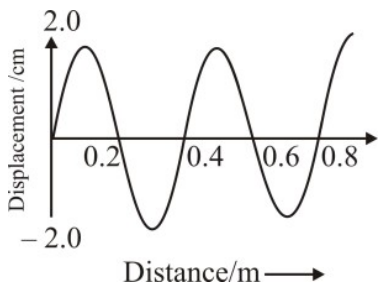
Q.19 Explain how human ear works in the transmission of sound wave to the brain.

Q.20 In the figure given here, a displacement-distance graph for a wave is shown. The wave velocity is 320 m/s. Find

(a) Wavelength

(b) Frequency

(c) Amplitude



Q.21 (a) Draw diagrams showing soft and louder sound.

(b) An orchestra, different musical instruments produce their own sounds. Do these sounds reach us with the same speed or different speed. Give reasons.

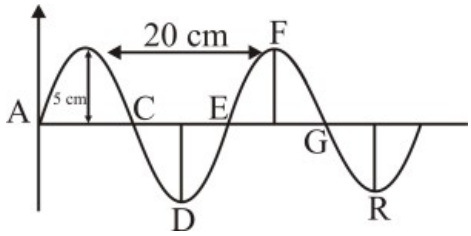
Q.22 Waves of frequency 100 Hz are produced in a string as shown in the figure. Give its :

(A) amplitude

(B) wavelength

(C) velocity

(D) nature



Solutions

1. h = 78. 4 m (height from which helmet fell)

$t_1 + t_2 = 4.23\,s$ (total time)

u = 0

$h = ut + \frac{1}{2}g{t_1}^2$ (if t_1 is the time for the helmet to reach the ground)

$78.4 = 0 + 12 \times 9.8 \times {t_1}^2$

${t_1}^2 = 16$

Therefore $t_1 = 4\,s$

Therefore $t_2 = 4.23 - 4 = 0.23\,s$

Speeds of sound $\frac{h}{t_2} = \frac{78.4}{0.23} = 340.9\,m/s$

---

2. Sound of single frequency is called tone

frequency ν= 500 Hz

Time interval between successive compression = $T = \frac{1}{\nu}$

$\frac{1}{\upsilon} = \frac{1}{500} = 0.002\,s$

---

3. SONAR stands for Sound, Navigation, and Ranging. Its two main parts are transmitter and receiver. SONAR technique is used for -

(i) Detection of underwater objects such as ice bergs , rocks etc

(ii) Detection of depth of sea.

---

4. (a) The echo should be heard after 0.1 s after the sound is produced.

(b) Bats emit ultrasonic waves, which are reflected from obstacles and prey and reach the bat's ear. These reflected waves make the bat know where the prey is located.

---

5. Speed V = 339 m/s

wavelength $\lambda = 1.2cm = 1.2 \times 10^{-2}m$

frequency $\nu = \frac{V}{\lambda} = \frac{339}{1.2\times10^{-2}} = 28250\,Hz = 2.8250 \times 10^{4}\,Hz$

---

6. Three medicinal applications of ultrasound are :

(1) Used in echocardio graphy to get image of heart

(2) Used in ultrasonography to get images of parts of body

(3) Used to break small 'stones' formed in the kidney.

---

7. (a) The driver will hear the sound of explosion first because sound will travel faster in water than in air.

(b) ν = 220 Hz

V = 440 m/s

Therefore $\lambda = \frac{V}{\nu} = \frac{440}{220} = 2m$

8. (a) Audible range 20 Hz−20,000 Hz

(b) Objects to be cleaned are placed in a cleaning solution and ultrasonic waves are sent into the solution. Due to the high frequency, the particles of dust, grease and dirt get detached and drop out. The objects thus get thoroughly cleaned.

9. (a) The stage of an auditorium has curved background, so that sound after reflection reach all corners of the auditorium curtains, carpets and false ceiling are used to reduce reverberation.

(b) The sound of a ringing bell inside a vacuum chamber cannot be heard because there is no medium through which sound could travel as sound is a mechanical wave.

10. T = 0.001 s

V = 15 m/s

Wavelength $\lambda = V \times T = 0.01 \times 15 = 0.15$ m

The distance between adjacent crest and trough $= \frac{\lambda}{2} = 0.075m$

11. Frequency $\nu = \frac{1}{T}$ where T is the time period

Wavelength $\lambda = 2\,cm = 2 \times 10^{-2}\,m$

Velocity v = 16 m/s

$\nu = \frac{V}{\lambda} = \frac{16}{2 \times 10^{-2}} = 800\,Hz$

$T = \frac{1}{\nu} = \frac{1}{800} = 0.00125\,s$

12. The persistence of sound due to its repeated reflection until it is not audible is called reverberation.

It can be reduced by covering walls and roof of halls by sound absorbent material like compressed fiberboard, rough plaster or draperies.

13. Sound waves are called mechanical waves because they travel by passing energy through particles in the form of compression and rarefaction.

14. Frequency ν = 2 Khz =2000 Hz

Wavelength λ = 45 cm = 0 .45 m

Therefore Velocity V = 2000 × 0.45 = 900 m/s

Distance travelled in 4 s = V × t = 900 × 4 = 3600 m

---

15. Time of echo = 6 sec

Velocity V= 330 m/s

Distance between source and cliff $= \frac{v \times t}{2} = \frac{330 \times 6}{2} = 990\,m$

---

16. (a) Frequency is the number of vibrations produced in 1 second. Its unit is Hertz (Hz)

(b) To reduce reverberation of sound.

---

17. Waves of frequency above 20,000 Hz is called ultrasound. It is used to clean parts, detect flaws, in echocardiography, ultrasonography, etc.

---

18. (a) Pitch is that characteristic of sound which gives sensation of shrillness. High pitch is more shrill. Higher the frequency, higher is the pitch.

(b) Quality of sound is that characteristic which enables us to distinguish one sound from another. It depend on the mixture of frequency and their relative amplitude

(c) Loudness is a measure of response of the ear to the sound .It depends on amplitude.

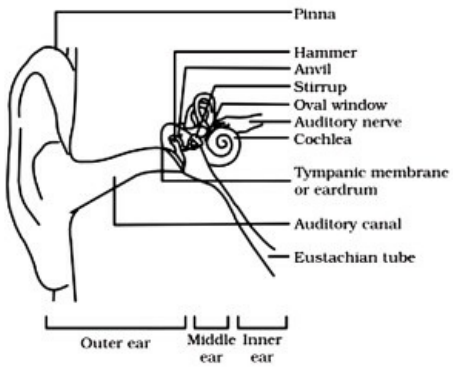
---

19. The human ear consists of three parts – the outer ear, middle ear and inner ear.

Outerear : This is also called ‘pinna’. It collects the sound from the surrounding and directs it towards auditory canal.

Middle ear : The sound reaches the end of the auditory canal where there is a thin membrane called eardrum or tympanic membrane. The sound waves set this membrane to vibrate. These vibrations are amplified by three small bones- hammer, anvil and stirrup.

Inner ear : These vibration reach the cochlea in the inner ear and are converted into electrical signals which are sent to the brain by the auditory nerve, and the brain interprets them as sound.



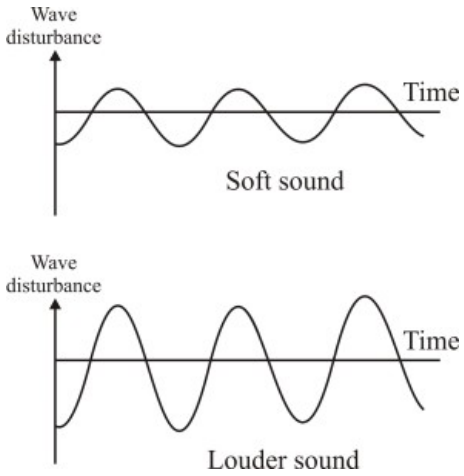
20. (a) Wavelength = 0.4 m

(b) Frequency $\nu = \frac{V}{\lambda} = \frac{320}{0.4} = 800\,Hz$

(c) Amplitude = 2 m

---

21. (a)



(b) All sound reach at the same time as all frequency have same speed.

---

22. Given Frequency
ν=100 Hz

(a)Amplitude = 5 cm

(b)Wavelength = 20 cm

(c)Velocity = Frequency × Wavelength $= 100 \times \frac{20}{100} = 20\,m/s$

(d)Transverse waves

5 Marks Questions

Q.1 (a) What is reverberation? How is it reduced?

(b) If the velocity of sound in air is 340 m/s, calculate the frequency of a wave whose wavelength is 1 m. Will it be audible to us?

Q.2 (a) Moths of certain families are able to escape capture when a bat is flying nearby. Explain how?

(b) What should be the minimum distance of the obstacle from the source of sound for hearing distinct echoes?

Q.3 (a) How does a sound wave propagate?

(b) What is the audible range of sound for human beings?

(c) It is observed that some animals get disturbed before earthquakes. How?

Q.4 (a) Why is the ceiling and wall behind the stage of good conference halls or concert halls made curved?

(b) Which property of sound leads to the formation of echoes? Briefly explain.

(c) What is reverberation? What will happen if the reverberation time in a big hall is too long? How can we reduce it?

Q.5 (a) The stone is dropped from a tower of 500 m height 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^{-1})

(b) How do the sound waves cause vibrations in the eardrum of human ear?

Q.6 (a) Draw a diagram depicting soft sound and a loud sound. What is the main difference between the two?

(b) Why are ceiling of concert halls and conference halls made curved? Explain by giving a diagram.

(c) Can two astronauts talk on the surface of the moon as they do on the surface of the earth? Why?

Solutions

1. (a) The persistence of sound due to multiple reflection within a room or hall is called reverberation. It is reduced by putting sound absorbing material in the room like curtains, cushion, false ceiling etc.

(b) V = 340 m/s

λ = 1 m

$$\nu = \frac{V}{\lambda} = \frac{340}{1} = 340\,Hz$$

It will be audible.

---

2. (a) Some moths can hear the high frequency squeaks of the bats. So when they hear the bats, they escape by flying away.

(b) Human beings can hear the echo only if sound returns after 0.1 s, if v is the velocity of sound, then minimum distance,

$$d = \frac{v \times t}{2} = \frac{v \times 0.1}{2}$$

$$\text{If we take V} = 340\ \text{m/s}$$

$$d = \frac{340 \times 0.1}{2} = 17\,m$$

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3. (a) Sound propagates by the vibrations of the particles in a medium in the form of longitudinal waves.

(b) 20 Hz - 20,000 Hz

(c) Some animals can hear low frequency sound produced by earthquakes and get disturbed.

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4. (a) The walls and ceilings are made curved so that sound reaches to all parts of the hall after reflection.

(b) The property which leads to the reflection of echoes is reflection. When sound is produced the wave can be produced by any large obstacle like wall or cliff. If the reflected sound reaches the observer after 0.1 s, a clear repetition of sound is heard which is called echo.

(c) The persistence of sound due to repeated reflection is called reverberation, echo may also be heard.

To reduce reverberation we can cover the wall and roof of hall by sound absorbing material.

5. (a) Height of tower = 500 m

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

Speed of sound = 340 m/s

Time for the stone to reach the water surface.

$$t_1 = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2\times500}{10}} = 10\,s \left[h = ut + \frac{1}{2}gt^2\ where\ u = 0\right]$$

Time for sound of splash to reach the top

$$t_2 = \frac{Distance}{Velocity} = \frac{500}{340} = 1.47\,s$$

$$\text{Therefore Total time } t_1 + t_2 = 11.47\,s$$

(b) Sound waves are produced by vibrations which travel in air in the form of longitudinal waves. When these waves reach the ear, these vibrations give the sensation of hearing.

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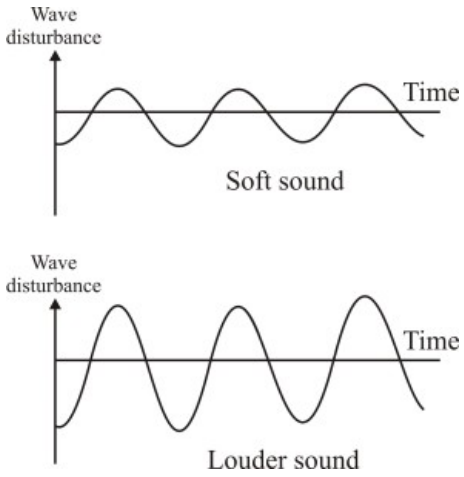
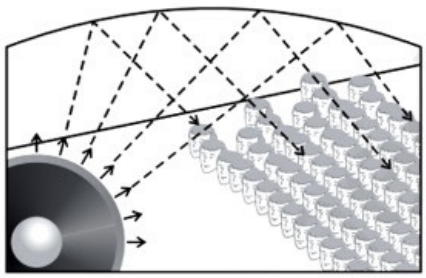
6. (a)



The main difference is that soft sound has small amplitude and loud sound has large amplitude.

(b)The walls and ceilings are made curved so that sound reaches all parts of the hall after reflection.



(c) No, because there is no atmosphere on the moon and sound cannot travel in vacuum.

Previous Year's Questions

1 Mark Questions

Q.1 Name two animals which can produce infrasonic waves.

[CBSE, 2012]

Hippopotamus and whale

Q.2 What is reverberation?

[CBSE (CCE), 2011]

Reverberation is defined as persistence of sound after the source has stopped emitting sound.

This is due to multiple reflections of sound waves.

Q.3 What is the frequency of wave with time period 0.025 s?

[CBSE (CCE), 2010]

Frequency (f) = 1/ time period (T)

$$f = \frac{1}{T} = \frac{1}{0.025} = 40\,Hz$$

Therefore, frequency of the wave = 40 Hz.

Q.4 A baby recognizes her mother by her voice. Name the characteristic of sound involved.

[CBSE (CCE), 2010]

The characteristic of sound involved in uniqueness of the sound is **quality of sound or timber.**

Q.5 What are infrasonic and ultrasonic sounds ?

[CBSE (CCE) 2010]

Infrasonic sound has frequency less than 20 Hz and ultrasonic sound has frequency higher than 20 kHz.

Q.6 What is the audible range of human ear?

[Board, 2010]

The audible range of human ear is 20 Hz to 20 kHz.

Q.7 Why do we hear sound of an approaching car before the car reaches us?

[Board, 2010]

This is because velocity of sound is much greater than the velocity of car.

2 Marks Questions

Q.8 What is SONAR? For what it is used?

[CBSE 2012]

SONAR is SOund Navigation And Ranging. It is a technique used to measure the depth of the sea, locate the sunken ships or icebergs and submarines.

Q.9 Write two points of difference between sound wave and light wave.

[CBSE, 2012]

Differences between sound and light waves:

Sound wave	Light wave
1. They of longitudinal waves and require a medium for propagation.	1. They are transverse wave and do not require a medium for propagation.
2. Speed of sound in air 332 m/s at 0°C.	2. Speed of light in air nearly 3×10^8 m/s.

Q.10 An echo is returned in 6 seconds. What is the distance of reflecting surface from source? [Given that speed of sound is 342 m/s.]

[CBSE (CCE), 2011]

Given,

Time in which echo returned, t = 6 s,

Speed of sound, v = 342 m/s

Distance = Speed × Time = 342 × 6 = 2052m

As this distance is twice the distance of reflecting surface from source.

So,

The distance of reflecting surface from source = 2052 / 2 = 1026 m.

Q.11 (i) Define the time period of a wave.

(ii) Give the relation among speed of sound v, wavelength λ and its frequency ν.

(iii) 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?

[Board, 2011]

(i) Time period (T) - It is defined as the time required to complete one wave.

(ii) Speed of sound (v) = Wavelength (λ) × Frequency (ν)

(iii) Given,

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

Wavelength, λ = 1.5 cm= 0.015m

Since, Velocity = Wavelength × Frequency

Therefore, $Frequency = \frac{Velocity}{Wavelength}$

$= 339m/s \times 0.015m$

= 22600 Hz

The frequency of wave = 22600 Hz

Q.12 A body is vibrating 6000 times in one minute. If the velocity of sound in air is 360 m/s, find:

(a) Frequency of vibration in hertz,

(b) Wavelength of the wave produced.

[Board, 2011]

(a) **Frequency of vibration in hertz**

Given,

Number of vibration in one minute = 6000

Number of vibrations in one sec = $\frac{6000\ vib}{60\ s} = 100Hz$

Therefore, Frequency, ν = 100 Hz

(b) **Wavelength of the wave produced**

Given,

Velocity of speed in air, v = 360 ms^{-2}

Frequency, ν= 100 Hz

Wavelength, λ = ?

$$v = \nu\lambda \Rightarrow \lambda = \frac{360 ms^{-1}}{100 s^{-1}} = 3.6\, m$$

The wavelength of the wave is 3.6 m

Q.13 Describe two uses of multiple reflections of sound.

[CBSE (CCE), 2010]

The phenomenon of multiple reflections of sound is used in Stethoscope and Megaphones.

3 Marks Questions

Q.14 (a) What is one vibration in a second called as?

(b) A tuning fork produces 256 waves in four seconds. Calculate the frequency of the tuning fork.

[Board, 2013]

(a) One **Hertz** (Hz) is defined as one vibration in one second.

(b) $Frequency = \frac{Number\ of\ waves}{Time} = \frac{256}{4} = 64\ Hz.$

Therefore, the frequency of the tuning fork is 64 Hz.

Q.15 (a) Suppose a person whistles standing on the moon. Will the person standing nearby hear the sound? Explain giving reasons.

(b) What kind of wave needs a material medium to propagate?

[CBSE 2013]

(a) No, the person standing nearby would not be able to hear the whistle as there is no atmosphere on the moon. Sound waves needs medium for travelling, but the moon has no medium for the propagation of sound. Therefore, no sound could be heard.

(b) Mechanical waves need material medium to propagate. For example: sound waves.

Q.16 A nail was gently touched by the hammer and then was hit harder.

(a) When will be the sound created louder?

(b) Which characteristic of sound here is responsible for change in sound?

(c) Give the SI unit of loudness.

[CBSE 2013]

(a) Sound is produced only when the nail is hit harder not when it is gently touched.

(b) Amplitude of the pulsating body.

(c) The SI unit of loudness is decibel (dB)

Q.17 What are ultrasonic waves? Name one animal which emits ultrasonic waves and explain how it uses the waves? What is the role of ultrasonic waves in medical science?

[Board, 2012]

Ultrasonic waves are those waves which have frequency more than 20 kHz.

Bats use ultrasonic waves to fly and search for their prey at night without colliding.

Bat produces ultrasound waves in the direction of its way and hear back the echoes produced by reflection of the waves while striking the object in the path. Through this process they judge the position of the object and change their path.

Role of ultrasound waves in Medical science:

- Imaging of internal body structure and functioning of heart in humans.
- Breaking of stones produced in kidney into smaller ones to flush out through urination.
- Observing the foetus development in the mother's womb for any abnormality or defect.

Q.18 Give reasons for the following:

(a) The reverberation time of a hall used for speeches should be very short.

(b) A vibrating body produces sound. However, no sound is heard when a simple pendulum oscillates in air.

(c) Sounds of same loudness and pitch, but produced by different musical instruments such as violin and flute are distinguishable.

[Board, 2012]

(a) The time for which the sound persists in the atmosphere after the sound has stopped producing from the source is known as **Reverberation time**. If reverberation time of a hall is long, then the multiple echoes produced would interfere with the original sound, and the speeches would not be heard clearly and distinctly.

(b) Sound is produced only when the frequency of the wave is greater than 20 Hz. As a simple pendulum produces waves less than 20Hz they cannot be heard.

(c) The quality or timbre is the characteristic which helps in distinguishing two sounds of same pitch and loudness. So, the musical instruments like violin and flute produces distinguishable sound.

Q.19 Define the term 'tone'. A person is listening to a sound of 500 Hz sitting at a distance of 450 m from the source of the sound. What is the time interval between successive compressions reaching his ears from the source?

[CBSE (CCE), 2012]

Tone is the sound of single frequency.

Given,

Frequency, ν = 500 Hz;

Distance, s = 450 m

Time period, T=?

$$T = \frac{1}{\nu} = \frac{1}{500} = 0.002\ s$$

Therefore, the time interval will be 0.002 s

Q.20 (a) State a condition for an echo to be heard.

(b) Bats cannot see, then how do they catch their Prey.

[CBSE (CCE), 2011]

(a) For echo to be heard the minimum distance between the source and the obstacle should be 17.2m.

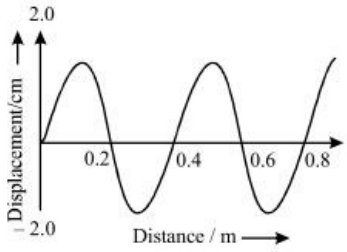
(b) Bats produce ultrasonic waves in the direction of their way. They hear back the echoes produced by the reflection of waves while striking their prey. By this the position of prey is judged and is being eaten by the bat.

Q.21 In the figure given here, a displacement-distance graph for a wave is shown. The wave velocity is 320 m/s. Find

(a) Wavelength

(b) Frequency

(c) Amplitude



[CBSE (CCE), 2011]

(a) Wavelength, λ = Distance between two consecutive crests = 0.4 m

(b) Frequency, $\nu = \frac{v}{\lambda} = \frac{320}{0.4} = 800\ Hz$

(c) Amplitude = During wave propagation, the maximum displacement of particles in a medium from mean position = 2 cm

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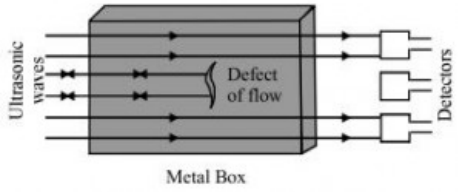
Q.22 Explain a technique to find fault in a block of metal using reflection of sound.

[CBSE, 2010]

Ultrasound waves are used to detect a fault in a block of metal using reflection of sound. These waves are made to pass through one side of the metal block. The detectors placed on the other side detect the transmitted waves. If there is any flaw or defect like crack or hole, etc. then ultrasound gets reflected back and does not reach the detector.



5 Mark Questions

Q.23 (a) Give three medical uses of ultrasound.

(b) A ship which is stationary is at a distance of 2800 m from the sea-bed. The Ship sends an ultrasound signal to the sea-bed and its echo is heard after 4 s. Find the speed of sound in water.

[Board, 2014]

(a) Ultrasound can be used in:

(i) Monitoring foetus during pregnancy.

(ii) Medical imaging of internal organs to check their size, structure and physiological functioning in humans.

(iii) Breaking kidney stones into smaller sizes to flush out in the urine.

(b) Given,

Distance, d = 2800 m

Time, t = 40 sec

Velocity, v =?

Total distance travelled by sound = speed of sound × time

So, $2d = v \times t$

$\Rightarrow v = 2d / t$

$\Rightarrow v = 2 \times 2800 / 4$

= 1400 m/sec

Q.24 State reason for the following statements:

(a) Ceiling of good conference halls and concert halls are curved.

(b) We hear sound produced by the humming bees while that of moving pendulum is not heard.

(c) Sound waves are mechanical waves.

(d) Sometimes we hear echo of sound.

(e) People in their old age suffering from hearing loss, wear hearing aids.

[Board, 2012]

(a) Ceiling of good conference halls and concert halls are curved so that the sound waves after reflecting from these walls reaches every part of the hall and can be easily heard by the listeners.

(b) We hear sound produced by the humming bees while that of moving pendulum is not heard. This is because the frequency of vibration of wings of bees is in the audible range of Humans (20Hz to 20 kHz) whereas frequency of vibrations of pendulum is less than 20 Hz so cannot be heard.

(c) Sound waves are mechanical waves as they need material medium for propagation which is the characteristic of the mechanical waves.

(d) We sometimes hear the echo of a sound produced because the distance between the source of the sound and the obstacle is at least 17.2.

(e) People in their old age suffering from hearing loss, wear hearing aids because hearing aid amplifies the electrical signal and converts it into sound which can then be heard much clearly by the old people.

(f) People in their old age suffering from hearing loss, wear hearing aids. This is because hearing aid amplifies the electrical signal and converts it into sound which can then be heard much clearly by the old people.

Q.25 (a) The stone is dropped from a tower of 500 m height 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 = 340 ms^{-1}).

(b) How do the sound waves cause vibrations in the eardrum of human ear?

[CBSE (CCE), 2010]

(a) Given,

Height of the tower, h = 500m

Time taken by stone to reach water surface from the top of the tower:

$$t_1 = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2\times500}{10}} = \sqrt{100} = 10\ s$$

Time taken by the sound to reach the object:

$$t_2 = \frac{h}{v} = \frac{500}{340} = 1.47\ s$$

Time at which splash is heard at the top:

$$= t_1 + t_2 = 10 + 1.47 = 11.47\ s$$

(b) Sound waves are longitudinal waves which vibrate back and forth in the direction of its movement. It consists of compressions and rarefactions which results in pressure variation in the medium. This causes vibrations in the eardrum of human ear with required frequency and hence the sound becomes audible.