GRADE – 9

LESSON : 12 SOUND (Chapter at a Glance)

WAVE: A disturbance which travels through a medium from one point to another and transfer energy.

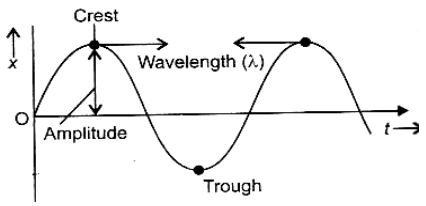
Based on propagating medium

Mechanical Wave: These waves require a material medium for their propagation. As they are produced by oscillations of particles of the medium.

Electromagnetic Waves: These waves do not require a material medium for their propagation. As they are produced by accelerating charged particles which travel at high speed depending on medium.

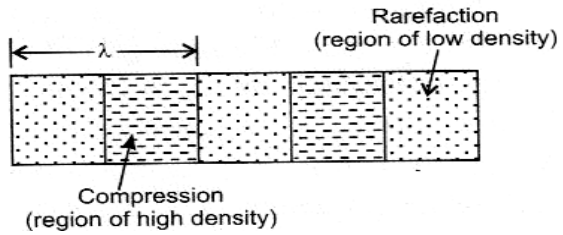
Based on oscillation of particles (Oscillation / Vibration is to and from movement of particles

Transverse Waves: The particles oscillate perpen-dicular to the direction of wave propagation.



Light Wave

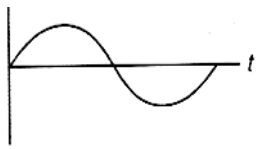
Longitudinal Waves: The particles vibrate parallel to the direction of wave propagation..



Sound Wave

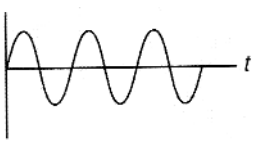
Frequency (v) : Number of waves produced per unit time is known as frequency it is measured in hertz (Hz)

Low Frequency Sound:



Low Pitch

High Frequency Sound:



High Pitch

Sound is detected by ear through which signals are transmitted to brain

Time taken to complete one oscillation is called time period (T)

Characteristics of Sound

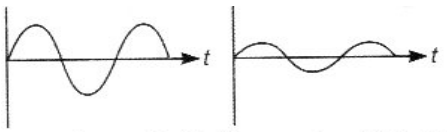
Wavelength (l): Distance between two successive compression or rarefactions.

Amplitude: Maximum displace ment of an oscillating particle from its mean position.

Intensity of sound: Amount of sound energy passing a unit area per unit

Quality of sound: To distinguish two sound. [Pleasant sound has rich quality]

Loudness



Loud sound Feeble sound or Soft sound

Velocity (v): Number of complete wavelengths per unit time.
Velocity = Wavelength x frequency

Speed of sound is maximum in solids and minimum in gases

Echo: Echo is the reflected sound

Multiple echoes lead to persistence of sound. This is called reverberation.

REFLECTION OF SOUND

Audible range of frequency in humans : 20Hz – 20kHz

Infrasonic sound has frequency less than 20Hz

Ultra sound has frequency more than 20 kHz

Application of ultrasound

Defence (echo ranging)

Industry (ultrasonic cleaning)

Medicine (echo cardiography and ultrasonography)

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Know the terms

Activity 1:

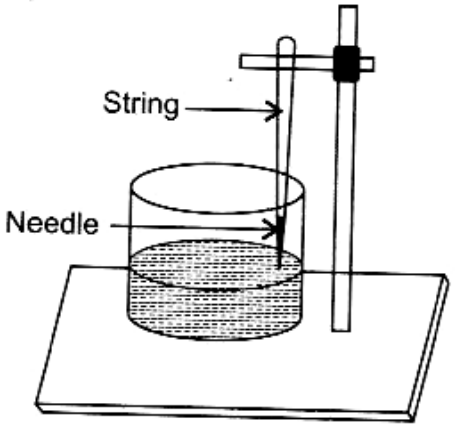
Objective : Experiment to understand wave motion using water waves.

Materials Required : Sharp needles, string, stand to hold the needles vertically.

Method :

1. Fix the needle vertically and support it with a string and stand just in contact with the surface of water
2. Give a small disturbance to the string such that the needle goes slightly in and comes out
3. Observe the surface of water for any motion with some coloured pieces of paper on it.
4. Repeat the same with disturbances of different extent.
5. Fix up one more set-up at some distance on the same surface of water
6. Disturb both the needles together and observe the wave formation and the motion of paper pieces.

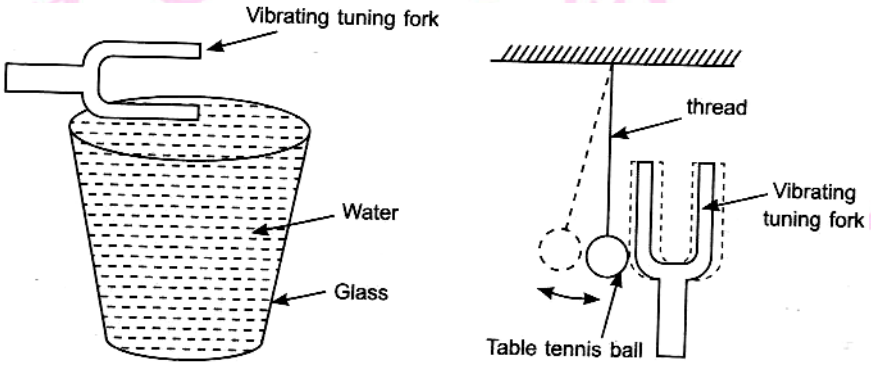
Conclusion : Waves are formed in the form of ripples on water. These are called transverse waves. The particles vibrate at their places as paper pieces don't travel to other places. Only energy is transferred from one point to another.



Activity 2

Objective : To verify that sound is produced by vibrations.

Materials Required : Tuning fork, rubber pad, glass, water, thread, table tennis ball, rigid support.



Method : 1. Take a tuning fork and strike its prong on a rubber pad to set it vibrating. Bring it close to your ear and try to hear the sound.

2. Suspend a table tennis ball from a rigid support with the help of a thread. Touch the ball gently with the prong of tuning fork. It moves away from the prongs.

3. Touch the vibrating prongs of tuning fork with still surface of water in a glass. The water surface starts vibrating.

Conclusion : When prongs of tuning fork are struck, they start vibrating. The sound is heard because vibrations produce sound. These vibrations can be sensed by brining the table tennis ball close to the tuning fork. The ball moves away as it strikes the vibrating prongs.
Similarly, surface of water starts vibrating when touched with prongs of tuning fork.

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Objective Type Questions

I. Multiple choice questions

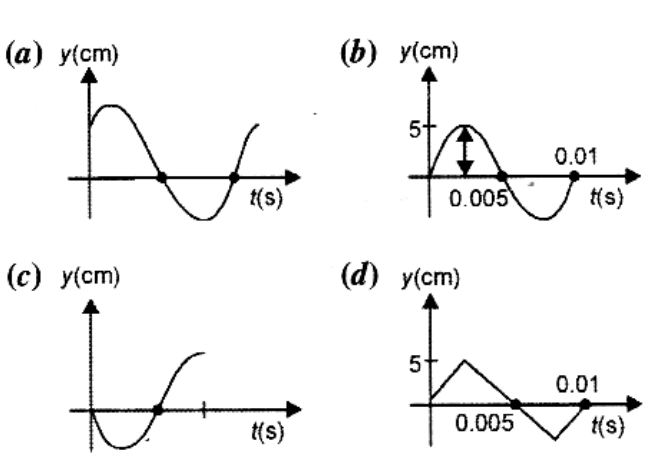
1. Wave Motion transfer

a) momentum b) velocity c) energy d) mass

2. Speed of light or electromagnetic wave is higher than that of the speed of sound in air by

a) 10^6 times b) 10^8 times c) 10^7 times d) 10^5 times

3. The wave having an amplitude of 5cm and frequency $f = 100\ Hz$ can be best represented by



4. Sonic booms are caused by the combination of

a) supersonic speed and pressure variation

b) infrasonic speed and pressure variation.

c) ultrasonic sound and pressure variation

d) pressure variation only.

5. Absorbent materials are to be used while making interior design in an auditorium as

a) echo is to be increased b) reverberation time has to be decreased

c) it has to look good d) sound travels with a lesser velocity

6. Infrasonic f_i Audible f_a and Ultrasonic f_u sound are related as

a) $f_i < f_a < f_u$ b) $f_a < f_i < f_u$ c) a) $f_{1i} > f_a > f_u$ d) $f_a < f_u < f_i$

7. Speed of sound in air and water are given as v_a **and** v_w respectively. Then

a) $v_a = v_w$ b) $v_a > v_w$ c) $v_w > v_a$ d) $v_a = 2v_w$

8. Which of the following is not the character of mechanical waves?

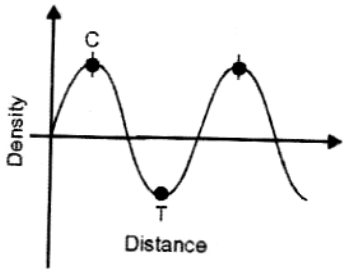
a) Propagation depends on the elasticity of medium

b) Can be both transverse or longitudinal

c) Requires a materials medium

d) Speed is comparatively higher

9. The separation between T and C in the figure given is



a) λ b) 2λ c) $\frac{\lambda}{2}$ d) 4λ

10. In the bell jar experiment, as air is removed

a) intensity falls b) speed of sound falls

c) both a and b d) elasticity falls

11. Two sounds of same pitch and loudness differ in their

a) tone b) note c) quality d) frequency

12. Echo is not heard in a room of 10m x 10m x 10 m dimension due to (speed of sound in air = 300 m/s)

a) reflection b) absorption c) persistence d) humidity

13. Sound of crackers is heard during festival days, but the sound of supernova explosion in space is not heard on the surface of earth because of

a) large distance b) absence of a medium

c) lesser gravity d) the influence of the other planets

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14. The instruments Megaphone, Stethoscope, Hearing aids and Sound boards work based on the principle of

a) reverberation b) reflection c) persistence d) absorption

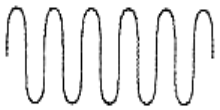
15. The penetrating powers of ultrasonic waves and other audible sounds are given as f_1 and f_2 respectively.Then

a) $f_1 = f_2$ b) $f_1 > f_2$ c) $f_1 < f_2$

16. A wave is moving with a speed of 3000 cm/s with reversal after every 0.01 second. The wavelength of the wave is

a) 0.06 m b) 0.6 m c) 6 m d) 60m

17. The pitch of the two signals A and B shown below are p_A and p_B respectively. Then

A.  B. 

a) $p_A = p_B$ b) $p_A > p_B$ c) $p_A < p_B$ d) $p_A = 2p_B$

18. Sonic booms are cause due to the variation of

a) pressure b) speed c) loudness d) humidity

19. The frequency of a visible light of a wavelength 600 nm is (speed of light = 3 x 10^8 m/s), (1nm = 10^{-9} m)

a) 5 x 10^{14}Hz b) 0.5 x $10^{16}$$Hz$ c) 50Hz d) 500Hz

20. The minimum size of a room required to hear an echo of sound with a speed of 300 m/s ,is

a) 16 m b) 15m c) 14 m d) 17 m

21. A bat can hear frequencies up to 120 kHz. Considering the speed of the should to be 300 m/s the wavelength of the signal is

a) 1.25 m b) 2.5 m c) 5 m d) 2.05 cm

22. A boat is rocked by waves such that a crest and a trough reach at an interval of 0.1 second with a speed of 50 m/s. The distance between two consecutive crests is

a) 5 m b) 10 m c) 15 m d) 20 m

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23. The terms ultrasonic, supersonic and infrasonic mean.

a) decreasing frequency b) increasing frequency

c) increasing loudness d) varying speed

24. Two audio devices of the same brand differ in their

a) quality of sound b) reverberation time

c) the speed of sound d) loudness

25. A pulse

a) is a short duration disturbance b) does not travel

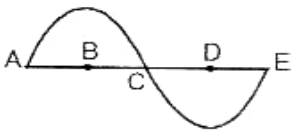
c) can travel d) remains at rest

26. When we change feeble sound to loud sound we increase its

a) frequency b) amplitude

c) velocity d) wavelength

27. In the curve half the wavelength is



a) AB b) B c) DE d) AE

28. Earthquake produces which kind of sound before the main shock wave begins

a) ultrasound b) infrasound c) audible sound d) as a supersonic wave

29. Infrasound can be heard by

a) dog b) bat c) rhinoceros d) human beings

30. Before playing the orchestra in a musical concert, a sitarist tries to adjust the tension and pluck the string suitably. By doing so, he is adjusting.

a) intensity of sound only b) amplitude of sound only

c) frequency of the sitar string with the frequency of the musical instruments

d) loudness of sound

1. c	2. a	3. b	4.a	5. b	6. a	7. c	8. d	9. c	10. a
11. c	12. c	13. b	14. b	15. b	16. b	17. b	18. a	19. a	20.d
21. b	22. b	23. a	24. a	25. a	26. b	27. b	28. b	29.c	30. c

I. Match the following

31. Match the Column I with Column II

Column I	Column II
1. Pitch	A. Amplitude
2. Loudness	B. Mechanical wave
3. Pulse	C. Sound
4. Transverse wave	D. Short duration
5. Longitudinal wave	E. Light
6. Sound	F. Frequency
7. Reverberation	G. Frequency less than 20 Hz
8. Ultrasound	H. Distance between two crests
9. Infrasound	I. Resistance of sound
10. Wavelength	J. Frequency more than 20kHz

1. F	2. A	3. D	4. E	5. C	6. B	7. I	8.J	9.G	10. H

I. Fill in the blanks

32. Dogs are capable of hearing _____sound

Ultrasonic

33. Reflected sound is called _____.

Echo

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34. Stethoscope is based on principle of _____reflections of sound

Multiple

35. Cushions, draperies and carpets reduce the effect of _____ in an auditorium.

Reverberation

36. Speed of sound _____with increase in temperature of medium

Increases

37. SONAR stands for _____.

Sound Navigation and Ranging

I. True or False

38. Due to higher humidity, speed of sound in Chennai is more than that of Delhi

True

39. SONAR works on the principle of echo ranging

True

40. Tone is a mixture of several frequencies

False

41. When sound travels from one medium to another, its frequency remain sun changed

True

42. Sound travels as longitudinal wave in air and transverse wave in water.

False

43. Light wave is mechanical wave.

False

44. Reflection of sound obeys same laws as those or reflection of light.

True

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Direction (Q-45 to Q -47) : IN the following Questions, the Assertion and Reason have been put forward. Read the statements carefully and choose the correct alternative from the following :

a) Both the Assertion and the Reason are correct and the Reason is the correct e of the Assertion

b) The Assertion and the Reason are correct but the Reason is not the correct explanation of the Assertion

c) Assertion is true but the Reason is false

d) The statement of the Assertion is false but the Reason is true.

45. **Assertion :** Sound of an approaching trains reaches earlier through tracks than through air.

Reason: Sound waves are mechanical waves and require a materials medium for their propagation.

(b). The Assertion and the Reason are correct but the Reason is not the correct explanation of the Assertion.

46. **Assertion** : An echo will be more clearly heard in a field surrounded by bushes and trees than an empty big hall.

Reason: Sound reflected by a surface can be detected if it reaches after a lag of 0.1 second when the original sound is produced.

(b) The Assertion and the Reason are correct but the Reason is not the correct explanation of the Assertion.

47. **Assertion:** We receive the heat and light from the sun but do not hear the sound of explosions occurring on its surface.

Reason: Sound waves cannot travel through empty space.

(a) Both the Assertion and the Reason are correct and the Reason is the correct explanation of the Assertion.

48. What is sound?

Sound is a form of energy which produces a sensation of hearing in our ears.

49. How is sound produced?

Sound is produced by vibrations.

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50. Can you produce sound without utilizing energy?

No, sound is a form of energy which is obtained by energy of vibration object.

51. List few ways in which we set objects vibrating to produce sound.

We can produce sound by striking, plucking, scratching, rubbing, blowing or shaking different objects to set them into vibration.

52. State the part of following musical instruments which vibrate to produce sound:

a) Flute **b) table** **c) Guitar** **d) harmonium**

a) air column b) stretched membrane

c) strings d) air column

53. How is the buzzing sound accompanying a bee produced?

The bee rapidly flutters its wings which vibrate and produce a buzzing sound.

54. What is a wave?

A wave is a disturbance which travels from one point to other and transfers energy.

55. Give tow examples of electromagnetic waves.

Light waves and Infrared wages

56. Give tow examples of mechanical waves

Sound waves and ripples on water surface.

57. What is the nature of sound waves?

Sound waves are longitudinal waves

58. Why are sound waves called mechanical waves?

Sound waves are produced by mechanical disturbances in the medium and cannot travel through vacuum.

59. What is a transverse wave?

A wave in which particles vibrate in a direction perpendicular to that of wave propagation is called transverse wave.

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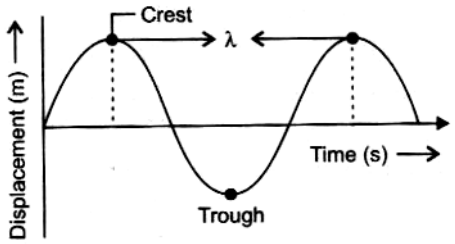
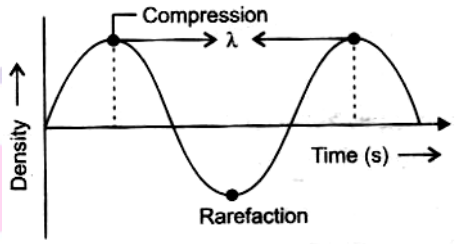
60. Draw a diagram of transverse wave and label it.



61. What is a longitudinal wave?

A wave in which particles vibrate in a direction parallel to that of wave propagation is called longitudinal wave.

62. Draw a diagram of longitudinal wave and label it



63. Give one example each of transverse and longitudinal wave each.

Transverse wage – Light

64. Name the part which vibrates to produce sound when we speak.

When we speak, our vocal cords vibrate on produce sound.

65. A bell is kept ringing in a closed jar. What happens if air is completely removed from the jar?

No sound of the bell will be heard if air is removed as sound requires a medium to propagate.

66. Define frequency of sound wave. State its SI unit

Frequency of wave is defined as the number of vibrations occurring per unit time. Its SI unit is hertz [Hz]

67. What is meant by time period of a wave? Tate its SI Unit

The time taken for one complete oscillation to take place is called tome period, Its SI unit is second(s).

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

Frequency = $\frac{1}{Time\ period}$

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

Oscillations in 1 minute [or 60s] = 150

Oscillations in 1 s (or4 frequency) = $\frac{150}{60}\ Hz$

∴ Time period = $\frac{1}{Frequency} = = \frac{60}{150} = 0.4s$

70. If a source of sound produces 500 compressions and 500 rarefactions in air in 25 seconds. Find the frequency of sound produced.

Complete wages produced in 25 seconds = 500

Complete waves produced in 1 second

= frequency = $\frac{500}{25} = 20s^{-1}$

Thus, frequency = 20 Hz

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

Time period, T = 0.025s

Frequency = $\frac{1}{T} = \frac{1}{0.025} = 40Hz$

72. Define amplitude and give its SI Unit.

Amplitude is defined as the maximum displacement of a particle from its mean position during vibrations, Its SI unit is metre (m).

73. What is wavelength of a sound wave?

The distance between two consecutive compressions or rarefactions in a sound wave is called wavelength (λ)

74. What is the reciprocal of a wavelength called?

Reciprocal of wavelength = Wave number = Number of complete waves in a length of 1m

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

V = $\frac{\lambda}{T}$ where v is the velocity, $\lambda\ is\ wavelength$

And T is the time period of a sound wave,

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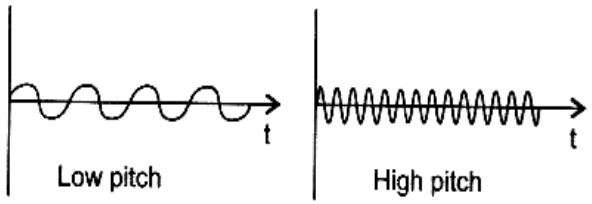
76. What is meant by speed of a sound wave?

The distance travelled by a sound per unit time is called speed of wave

77. What is pitch of sound?

The way in which brain interprets the frequency of emitted sound is called its pitch. It measures the shrillness of sound.

78. Distinguish between high pitched and low pitched sound with the help of diagram.



Low pitch has less number of waves per unit time and high pitch has more number of waves per unit time.

79. How do we determine loudness or softness of sound?

The loudness or softness of sound is determined by its amplitude. The amplitude of sound depends on the force with which the object is set to vibrate. Large amplitude means loud sound whereas small amplitude means soft/feeble sound.

80. Why do we hear up to a large distance if a table is banged upon hard?

Loud sound is produced when we hit the table hard. It is associated with higher energy and travels a larger distance.

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

Quality / timbre of sound.

82. On what factors does the quality of the sound depend?

Quality of sound describes how different frequencies are mixed to produce pleasant sound. Quality of the sound is affected by ambience, speaker etc.,

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83. 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?

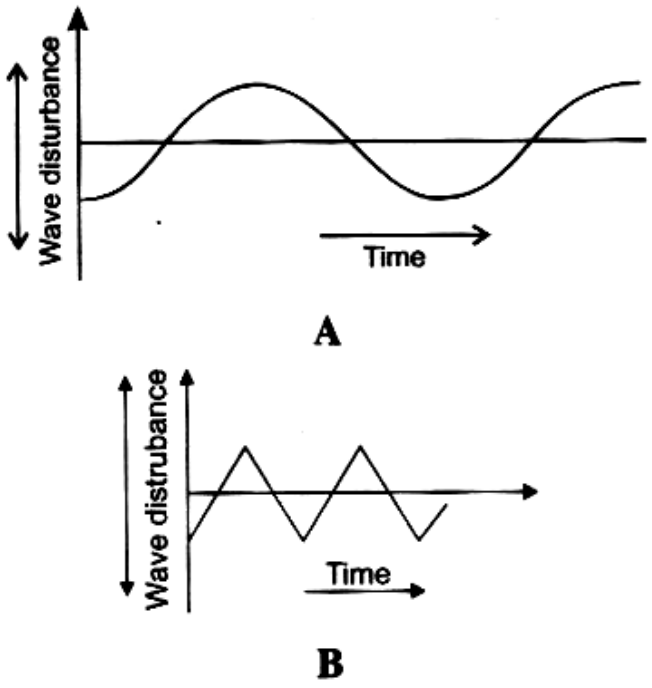

Figure B shows car – horn because due to higher frequency, pitch is higher.

84. What is meant by quality of sound?

Quality of sound is that characteristic which enables us to distinguish one sound from another having the same pitch and loudness.

85. Distinguish between tone and note of sound

Tone is a sound of single frequency while note is produced by7 mixing several frequencies.

86. How is noise different from music?

Noise is produced by irregular vibrations and causes irritating effect on our ears. Music causes soothing and pleasant effect on ears.

87. How does speed of sound change with temperature of medium?

In a medium, when we increase temperature the speed of sound increases. For example. Speed of sound in air at 0^0 C = 331m/s

88. What happens to sped of sound when it goes from solid to gaseous state?

The speed of sound is maximum in solids and minimum in gases.

For example. Speed of sound in iron = 5100m/s

Speed of sound in water = 1450 m/s

Speed of sound in air = 344 m/s at given temperature.

89. What is the audible range of frequency is humans?

20Hz – 20000 Hz

90. What are infrasonic and ultrasonic sounds?

Sounds of frequency less than 20Hz are infra sounds.

Sounds of frequency more that 20KHz are ultrasounds

91. What do you mean by seismic waves

Waves produced under the crust of the earth during an earthquake are called seismic waves

92. Why do some animals get disturbed before earthquakes?

Elephants, rhino etc., get disturbed before earthquakes because earthquakes produce low frequency infrasound before actual shock waves begin. This alerts these animals as they can detect infrasound.

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

Richter scale

94. What is an echo?

An echo is the reflected sound

95. What is reverberation? [CBSE 2011]

Reverberation is defined as persistence of sound due to its multiple reflections.

96. Write the full form of SONAR

Sound Navigation and Ranging

97. Briefly explain the term "Ultrasonography'

The ultrasonic waves are directed to travel through the tissues of the body and get reflected from a region where there is a change in tissue density. These waves are converted into signals and images are obtained on the monitor or a film. This technique is called ultrasonography.

98. Give two properties of sound waves

Sound waves have following properties

i) These are longitudinal waves

ii) These are produced by vibrations

iii) These are mechanical waves

iv) Their speed is least in gases and maximum in solids [any two]

99. Differentiate between mechanical waves and electromagnetic waves

Differences

Mechanical Waves	Electromagnetic Waves
1. Requires a medium to travel 2. Produced by mechanical disturbances in a medium	1. Does not require any medium to ravel and can travel through vacuum. 2. Produced by oscillating charged particles.

100. Sound is produced when our school bell is struck with a hammer, why?

When the school bell is struck, it starts vibrating. These vibrations produce disturbance in air, which travels as sound waves to our ear.

101. Which characteristic of sound helps to identify your friend by his voice while sitting with others in a dark room? [CBSE 2011]

Quality / Timbre4 of sound

102. Sound of explosions taking place on other planets is not heard by a person on the earth. Give reason [CBSE 2011]

OR

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

Sound cannot travel through vacuum. Since, there is empty space between other planets and earth, we can't hear sound of explosions occurring on other planets.

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103. "The disturbance created by a source of sound in the medium travels through the medium and not the particles of the medium". Just6ify this statement [CBSE 2013]

The wave propagates to transfer energy from one point of medium to another. The medium particles oscillate at their respective positions and do not travel any where else into the medium.

104. a). Which wave property determines

i) Loudness, ii) Pitch?

b) How are wavelength and frequency related to speed of sound waves? [CBSE 2011]

a). i. Amplitude ii. Frequency

b). Speed of sound wave = Wavelength x Frequency

105. What is meant by "Compression" and 'Rarefaction' of a longitudinal wave?

Compression and rarefaction are the points of maximum and minimum density in a longitudinal wave.

106. How does amplitude help to explain loudness of sound produced?

Greater the amplitude of vibration. Louder is the sound produced.

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

a). Transverse waves (vibrations of strings)

b). Longitudinal waves (Sound)

108. How does speed of sound change with

a) Temperature of medium

b) Physical state of medium?

(a) Speed of sound increases when temperature of medium increases

(b). Speed of sound is maximum in solids and minimum in gaseous medium.

109. On which day, a hot day or a cold day, an echo is heard sooner, why?

Speed of sound is faster on a hot day than on a cold day. Thus, echo is heard sooner on a hot day.

110. How does sonic boom occur?

When an aircraft travels at a greater speed than that of sound, it is said to have supersonic speed. This produces shock waves with large energy in the surroundings. This is called sonic boom.

111. 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 2s. [CBSE 2016]

Wavelength = Distance between successive crests

= 2 x 30cm = 60cm = 0.6m

Waves produced in 1 s = $\frac{10}{2}$ = 5 Hz = frequency

112. A sound wave travels at a speed of 342 m/s. If the3 wavelength is 1.5cm, what is the frequency of the wave? Will it be audible? [CBSE 2013]

Wavelength, λ = 1.5cm = 0.015m

Speed v = 342 m/s

Frequency, v = v/λ = $\frac{342}{0.015}$ = 22800 Hz

Since v >20 KHz, the sound is inaudible.

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

Frequency, v = 3 kHz = 3000 Hz

Wavelength, λ = 45cm = 0.45m

Number of waves in 1.8 km (1800m) = $\frac{1800m}{0.45m}$ = 4000

Time period = $\frac{1}{Frequency} = \frac{1}{3000}$s

$\therefore$ Time for 4000 waves = $\left(4000 \text{ x } \frac{1}{3000}\right)$s

= 1.3 s.

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

Person	Medium
A	Iron Red
B	Air
C	Water

Who will hear the sound first and why?

A will hear the sound first. This is because the speed of sound is maximum in solids.

115. Distinguish between echo and reverberation. Echo : Echo is caused by reflection of sound from given surfaces.

Reverberation : The persistence of sound caused by multiple echoes is called reverberation.

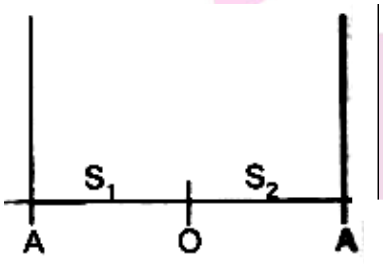
116. Sound produced by thunderstorm is heard 10s after the lightening is seen. Calculate the approximate distance of the thunder cloud.

(Given speed of sound in are = 340 m/s)

Speed of sound v= 340 ms^{-1}, Time, t = 10s.

Distance of thunder cloud = vt = 340 x 10 = 3400m

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



Let A and B be cliffs at distance 's' from each other so that, s = s_1 + s_2

Distance travelled by sound O to A and back = 2 s_1

∴ 2 s_2 = speed x time

= 330 ms^{-1} x 2 s

ated by Pinkz

s_1 = 330 m

Distance travelled by sound O to B and back = 2 s_2

$\therefore$ 2 s_2 = speed x time

= 330 ms^{-1}x 2.5s

$s_2 = \frac{330 \times 2.5}{2} = 412.5m$

Total $distance, s = s_1 + s_2 = 330\text{m} + 412.5\text{m} = 742.5\text{m}$

118. State any one application of echo ranging.

It is used to detect under water objects such as submarines, ice – bergs etc.,

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

Ultrasonic Sound: Ultrasonic frequencies are of higher frequency than ordinary sound waves. They have very good penetrating power than ordinary waves. Ultrasonic sounds are used in :

i) Finding depth of sea, enemy submarines through SONAR,

ii) To detect growth of foetus and the pulsation of arterial walls.

120. A hospital uses an ultrasonic scanner to locate tumours 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 (1 MHz = 10^6Hz)

V = 1.7km/s = 1700 m/s;

V = 4.2MHz = 4.2 x 10^6Hz

$\lambda = \frac{v}{V} = \frac{1700}{4.2 \times 10^6}$ = 4.047 x 10^{-4}m.

121. Briefly explain echo ranging

The process of sending ultrasonic waves in water and detecting the reflected wave to measure the depth of the ocean bed or an underwater object is called echo ranging.

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I. Short answer type questions

122. Name the types of waves and two examples associated with

a) Compressions and rarefactions

b) Crests and troughs [CBSE 2015]

(a) Longitudinal waves : Sound waves, ripples in water.

(b) Transverse waves ; Light waves infrared waves

123. Sound waves are mechanical waves. Justify it with different examples [CBSE 2013]

Sound waves need a material medium for their propagation. These waves cannot travel through vacuum. Thus they are called mechanical waves for example. We can receive light coming from sun, but do not hear the sound of explosions occurring on its surface.

124. 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?

(a) The number of complete oscillations in one second is called frequency (f). Its SI Unit is hertz (Hz)

(b) If absorbent materials are absent, there will be multiple echoes due to which sound cannot be heard clearly.

125. 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 16m/s, find its frequency and Time period [CBSE 2011]

Frequency = $\frac{1}{Time\ period}$

λ = 2cm = 0.02m: v = 16m/s: v = vλ

or $v = \frac{v}{\lambda} = \frac{16}{0.02} = 800\ Hz$

$T = \frac{1}{v} = \frac{1}{800} = 0.00125s$

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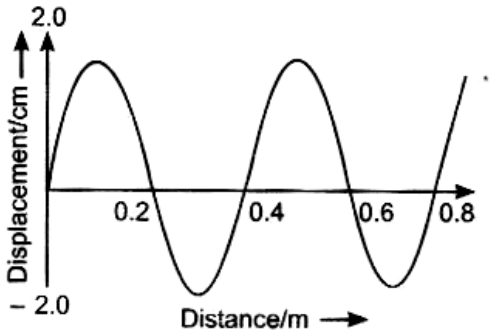
126. Define the term "tone". A person is listening to a sound of 500Hz sitting at a distance of 450m from the source of the sound. What is the time interval between successive compressions reaching his ears from the source? [CBSE 2012]

Sound of single frequency is called tone.

V = 500Hz. S = 450m

T = $\frac{1}{v} = \frac{1}{500} = \mathbf{0.002}s$

127. In the figure given here, a displacement distance graph for a wave is shown. The wave velocity is 320 m/s. Find [CBSE 2011]



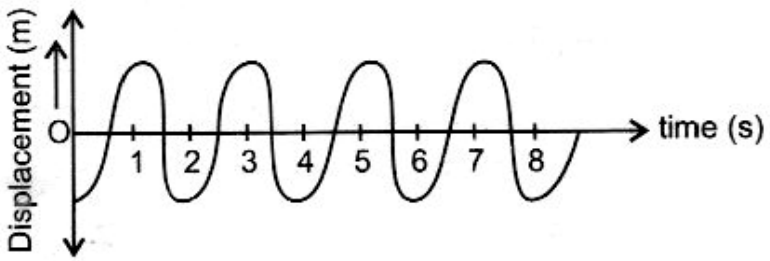
a) Wavelength b) Frequency c) Amplitude

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

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

(c). Amplitude = 2m

128. Calculate time period, frequency and wavelength if disturbance travels with a velocity of 1500 m/s in the following case:



Time period T = 2 s (in which one wave is complete)

Frequency, V = $\frac{1}{T} = \frac{1}{2} = \mathbf{0.5}Hz$

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129. What is an echo? Prove that to hear a distinct echo. Distance between observer and reflecting surface should be atleast 17.2 m at temperature, say 22^0 C when speed of sound in air is 344 m/s Why do we hear echo in empty halls and not in well furnished rooms of the same size?

An echo is a reflected sound.

Speed of sound = v = 344 m/s

T = 0.1 s which is the required time lag between original sound and echo.

Distance travelled by sound is 2s (where s is distance between observer and surface).

i.e. from source to surface and back

$\therefore \quad 2s = vt$

Or $\quad s = \frac{vt}{2} = \frac{344\,x\,0.1}{2} = 17.2m$

Well furnished rooms have carpets, curtains, cushions, draperies etc. which absorb sound and echo is not produced. But walls of empty halls reflect the sound back and we hear echo.

130. a) State a condition for an echo to heard

b) Bats cannot see, then how do they catch their prey?

a) Reflecting surface should be at a distance such that echo reaches our ears after a time lag of at least 0.1 second.

b) Bats send ultrasonic squeaks which are reflected back when they strike a prey. The bats detect this reflected wave and catch their prey.

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

The time from generation of sound till its loudness reduces to zero is called reverberation time. The process due to which the persistence of sound is caused is called reverberation. This is reduced in an auditorium using sound absorbent materials such as carpets, draperies, curtains and custion covers.

Applications of reflection of sound waves

Stethoscope, megaphones, loudspeakers etc.,

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132. 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? [CBSE 2011]

(a) It is made in such a manner that it can reflect sound evenly across the width of hall so that the sound is clearly heard. Curtains help to absorb the reflected sound.

(b) Sound waves are mechanical waves and cannot pass through vacuum.

133. On a cloudy day, a thunder sound was heard 14s, after the flash of lightning was seen. How far was the cloud? Given the speed of sound 340 m/sec

Speed of sound = 340 ms^{-1}; $time = 14s$,

Distance of cloud = Speed of sound x Time = 340 ms^{-1} x 14 = 4760 m = 4.76 km

134. A girl is sitting in the middle of a park of dimension 12m x 12m. On the left side of it there is a building adjoining the park and on right side of the park, there is a road adjoining the park. A sound is produced on the road by a cracker. Is it possible for the girl to hear the echo of this sound?. Give reason to justify your answer. Given that speed of sound in air is 344 ms^{-1} [CBSE 2016]

Distance travelled by sound and its echo

= Length of park

+ $\frac{1}{2}$ length of park (echo)

= 12 m + 6 m = 18 m

Speed of sound = 344m/s; Time taken

= $\frac{18m}{344\ ms^{-1}}$

Similarly, time taken by original sound

= $\frac{6m}{344\ ms^{-1}}$

Time lag between echo and original sound

= $\frac{18}{344} - \frac{6}{344} = \frac{12}{344}$ s

= 0.03s

Since 0.03 s < 0.1 s, the girl cannot detect the echo

($\because$ *our ears can detect an echo only when it reaches after a time gap of atleast* $0.1s$)

135. What is ultrasound ? what is its use in industry? Why cannot we use longer wavelengths from such uses?

Ultrasound is the sound of frequency greater than 20000Hz. In industry, it is used for;

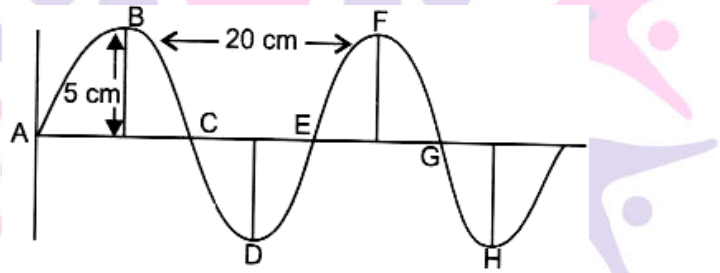
a) Cleaning parts located in hard to reach places such as coiled tubes, electronic components, odd shaped objects etc.,

b) Detecting cracks and flaws in metal blocks used in construction of big structures such as bridges, machines, building etc.,

We cannot use longer wavelengths for such uses because they might bend around the corners of defective location and enter the detector.

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

a). Amplitude b) wavelength c) velocity d) nature



a) Amplitude = 5cm

b) Wavelength = 20cm

c) Velocity (v) = λf = 20 x 10^{-2} x 100 = 20 m/s

d) Transverse wave in the string.

137. 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 330m/s?

V = 330 ms^{-1} , t = 6s

d = $\frac{vt}{2}$ = $\frac{360 \times 6}{2} = 990m$

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

Speed (v) = $f\lambda$ = 2 x 10^3 x 45 x 10^{-2}

= 900 m/s

Distance = vt = 900 x 4 = 3600m

= 3.6km.

139. A sound wave travels at a speed of 339 m/s. If the wavelength is 1.2cm, what is the frequency of the wave? [CBSE 2011]

Speed v = 339 m/s

Wavelength, λ = 1.2cm = 0.012 m

Frequency v = $\frac{v}{\lambda} = \frac{339}{0.012}$ = 28250 Hz

140. 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 in air. [CBSE 2011]

Distance = h = 78.4m, t = 4.23 s = Time taken by helmet (t_1) + time taken by sound (t_2)
Initial velocity of helmet, u = 0; g = 9.8 m/s^2

$\therefore$ h = $\frac{1}{2}gt_1^2$

Or $t_1 = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2\times78.4}{9.8}} = 4s$

$\therefore t_2$ = t - t_1 = 4.23 – 4 = 0.23s

$\therefore$ Speed of sound in air = $\frac{h}{t_2} = \frac{78.4m}{0.23s}$

= 340 m/s

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

b) Calculate the wavelength of a sound wave whose frequency is 220Hz and speed is 440m/s in a given medium [CBSE 2011]

(a) The diver will hear the sound first as sound travels faster in water than in air

(b) V = 220 Hz; v = 440m/s;

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

142. a) What is audible range of the average human ear?

b) Explain how ultrasound is used to clean spiral tubes and electronic components? [CBSE 2011]

(a) 20Hz – 20000 Hz

(b) Ultrasonic waves are sent through the cleaning solution in which spiral tubes or electronic components are kept. Due to high frequency of ultrasound waves, dust and dirt get detached and drop out.

143. Write three medical applications of ultrasound. [CBSE 2011]

Medical applications of ultrasound are:

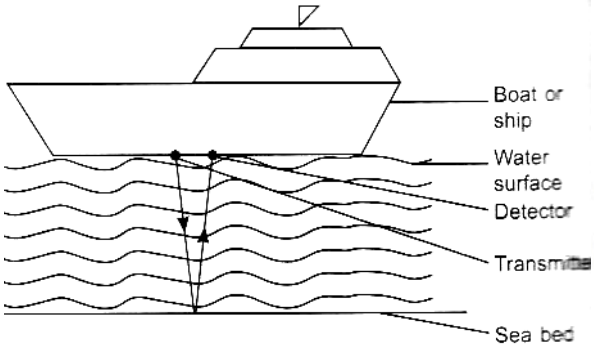
a) Echo cardiography: Ultrasonic waves are made to reflect from various parts of heart and form image of heart. This is called echo cardiography.

b) Ultrasonography: Ultrasound scanner helps to obtain images of internal body organs in a technique called ultasonography. It is used for examination of foetus, stones in gall bladder or kidney and tumours in different organs.

c) Ultrasound is used to break small stones in kidney into fine grains which are later flushed out with urine.

144. What is SONAR? Explain with the help of labelled diagram how does it work? [CBSE 2015]

SONAR [Sound Navigation and Ranging] works on the principle of reflection of sound. Sound waves are sent into the water by SONAR DEVICE. These strike the underwater objects such as rocks, ice bergs and even submarines and get reflected back. The reflected waves are detected by detector and time taken by them to return back is measured. This helps to measure depth of objects in the sea.



145. Waves of higher frequencies are used to measure depth of the sea.
[CBSE 2014]

a) Name these waves

b) Give the frequency of these waves

c) Give one more use of these waves

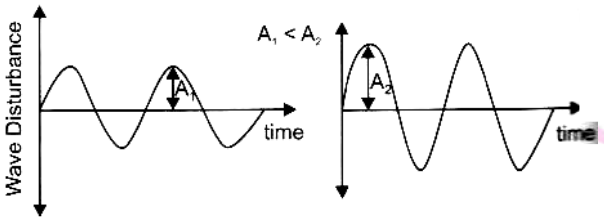
(a) Ultrasonic waves.

(B) Waves of frequency greater than 20 kHz

(c) These waves are used in medical science for echo cardiography and ultrasonography. These are also used to detect flaws in metal blocks and ultrasonic cleaning.

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

Intensity is defined as the amount of energy passing through a unit area per unit time. Loudness is determined by amplitude of the sound. If the amplitude is more, the sound will be loud. Louder sound is caused by the external force of large magnitude. This isa relative term because a sound louder for a person is soft for another.



Loudness of first < Loudness of second

147. What is SONAR? Write two uses of SONAR technique?

SONAR: Sound Navigation and Ranging.

Uses:

i) To identify enemy submarines and locate the underwater obstacles on the way.

ii) To test metals for perfection and detect flaws in it.

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Long answer types questions

148. a). How does a sound wave propagate? [CBSE 2012]

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

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

(a) A sound wave propagates as longitudinal wave, in the form of compressions and rarefactions through a medium. When an object vibrates. It sets the medium particles around it vibrating. These exert force on adjacent particles which also start vibrating. This process continues till the sound reaches our ears.

(b) Audible range of frequency

= 20 Hz – 20000 Hz

(c) Earthquakes produce low frequency infrasound before the main shock waves begin. This alerts the animals and disturbs them.

149. (i) The units of certain parameters of a mechanical waves are given

Name the corresponding parameter of a mechanical wave and define each

a) Metre b) metre per second c) hertz d) second

(ii) Two sounds A and B are of different pitch B appears to be heavier as compared to A. What can be said about their comparative frequencies [CBSE 2015]

(i) a. Wavelength: It is the distance between two consecutive compressions or rarefaction in the wave.

(b) Velocity / Speed: Distance travelled by wave per unit time is called wave speed.

(c) Frequency: The number of complete wave cycles occurring per unit time is called frequency of wave.

(d) Time period: The time taken by one complete wave cycle is its time period

Time period = $\frac{1}{frequency}$

(ii) Since B has a heavier sound. The pitch is lower than that of A. Thus, its frequency is less than that at A.

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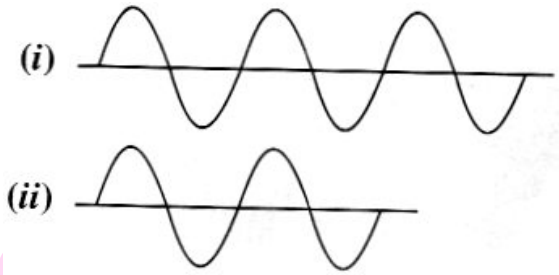
150. Two waves are shown below.



a) Which of the two waves corresponds to high pitched sound?

b) Name the characteristics of sound the graphs represent

c) Define the characteristic.

d) Explain the reason why sound of a school bell is heard over long distance while that of a blow by hand on a wooden desk remains limited to room [CBSE 2015]

(a) None corresponds to high pitched sound as frequency is less

(b) The graphs represent amplitude. Wavelength time period and frequency of sound

(c) Wavelength – The distance between two points in consecutive waves having the same phase is called wavelength.

Frequency – The number of complete oscillations in one second is called frequency

Time period – Time taken for one complete oscillation to occur is called time period

Amplitude – Maximum displacement of an oscillating particle from the mean position is called amplitude.

(d) Amplitude of vibrations produced by school bell is more, so wave travels a longer distance in the surroundings. Since amplitude of sound produced on desk is small, waves travel lesser distance and gradually die down.

151. What is an echo? State two conditions for an echo to be heard. Bats cannot see, then how do they catch their prey? Explain [CBSE 2015]

Reflected sound is called echo

i) Reflecting surface should be at a distance such that echo reaches our ears after a time lag of at least 0.1 second.

ii) Reflecting surface should not absorb the sound and must reflect sound properly.

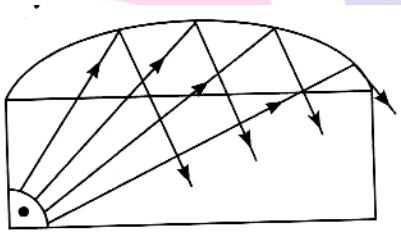
Bats send ultrasonic squeaks which are reflected back when they strike a prey. The bats detect this reflected wave and catch their prey.

152. a) How can multiple echoes of a single sound be produced ? Explain

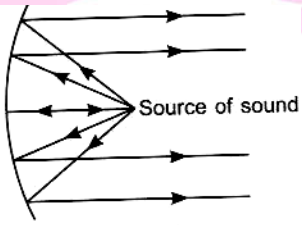
b) In an orchestra, different musical instruments produce their own sounds. Do these sounds reach us with the same speed or different speed? Give reasons.

a) Multiple echoes of a single can be produced by making the ceilings curved. This is generally done in concert halls, conference halls and cinema halls, so sound after reflection reaches all corners of the hall.

A sound board may also be placed behind the stage so that reflected sound from sound board spreads evenly across the hall.



Curved ceiling



Sound board

b) Speed of sound is same as the medium is same. But frequency and quality of sound are not the same.

153. A boy watches Dussehra celebrations from a distance and sees effigy of Ravana burn into flames and hears the explosion after 2s. How far was he from the effigy if the speed of sound in air was 335 m/s?

Time taken by sound, t = 2s

Speed of sound in air, v = 335 m/s.

Distance = vt = 335 m/s x 2s = 670m

154. What is reverberation? How can it be reduced? Give two applications of reflection of sound wave.

Reverberation is the persistence of sound due to multiple echoes. In concert halls and auditoriums it is reduced by using sound absorbing material such as carpets, curtains and ceiling covers.

Applications of reflection of sound waves are :

a) Megaphones, horns, trumpets etc. Are so designed that sound emerging from the tube reaches a conical opening which reflects sound repeatedly and directs it forward towards the audience.

b) In stethoscopes, the sound of patient's heartbeat reaches doctor's ears by multiple reflections of sound.

155. a) Why is the ceiling and wall behind the stage of good conference halls or convert 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?

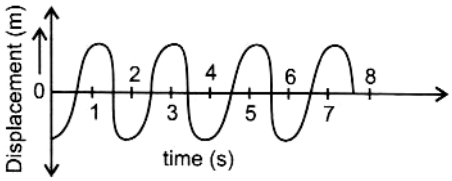
a) A Ceiling and wall behind the stage of conference halls and concert halls are made curved so that the reflected sound from them spreads evenly across the width of the hall.

b) The property of sound to get reflected from a surface of solid or liquid, and to persist in our brain for a very short time (≈ 0.1 s) leads to formation of echoes.

c) The repeated reflection of sound that results in its persistence is called reverberation.

Excessive reverberation for too long over laps with subsequent original sound and makes it unclear to hear. To reduce reverberation, roofs, seats and walls of the hall are covered with sound absorbent material such as compressed fibre board, draperies or rough plaster.

156. a) The given graph shows the displacement versus time relation for a disturbance travelling with a velocity of 1500 ms^{-1}



Calculate the

i) Time period **ii) Frequency** **iii) Wavelength of disturbance**

b) The velocity of sound in air is 340 m/s. Compute

i) its wavelength when the frequency is 250 Hz.

ii) its frequency when the wavelength is 85 cm

a) v = 1500 m/s.

From graph,

i) Time period, T = 2s

ii) Frequency = v = 1/T = 0.5 Hz

iii) Wavelength (λ) = $\frac{v}{v}$ = 1500/0.5

= 3000m

b) i) v = 340 m/s, v = 250Hz

$\lambda = \frac{v}{v}$ = 340/250 = 1.36 m

ii) If λ = 85cm = 0.85 m

then frequency v = v/λ = 340/0.85

= 400 Hz

157. a). What is reverberation? How is it reduced?

b). If the velocity of sound in air is 340m/s. Calculate the frequency of a wave whose wavelength is 1m. Will it be audible to us? [CBSE 2012]

(a) The time from generation of sound till its loudness reduces to zero is called reverberation time. The process due to which the persistence of sound is caused is called reverberation. This is reduced in an auditorium using sound absorbent materials such as carpets, draperies, curtains and custion covers.

Applications of reflection of sound waves

Stethoscope, megaphones, loudspeakers etc.,

(b) v = 340m/s $\lambda = 1m$

V = $\frac{v}{\lambda}$ = $\frac{340}{1} = 340\ Hz$

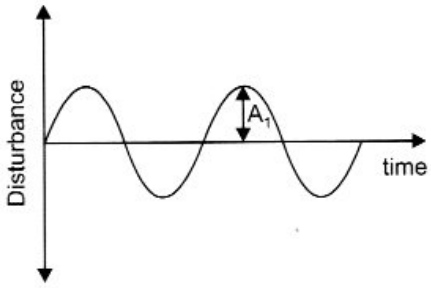
It will be audible to us. As it lies in audible range of frequency

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

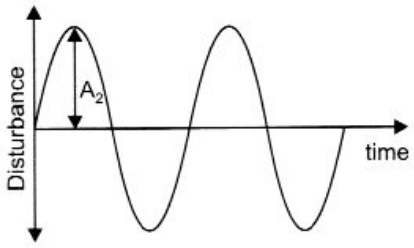
b) Why are ceiling of concert halls and conference halls made curved? Explain with a diagram.

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

(a) Loudness or softness is due to the amplitude of the sound. Greater the amplitude, louder will be the sound. Greater the amplitude, louder will be the sound. Louder sound is caused by the external force of larger magnitude. This is purely relative as "A sound louder for a person can be mild or soft for another." This depends on intensity which is the amount of energy passing through unit area in one second.



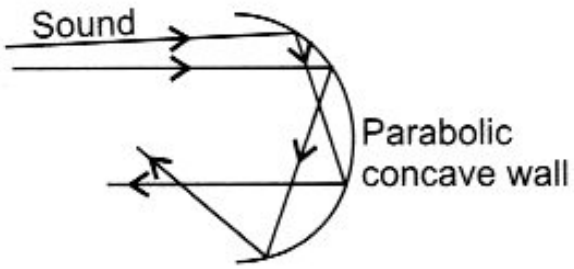
Soft sound



Loud sound

$A_1 < A_2$

b) Reflection of sound from parabolic concave back walls spread the sound uniformly throughout the room, even to the last corner, so, the audience at the back portion also listen clearly. It can be understood by the following diagram



c) No, as there is no atmosphere on the moon. Sound cannot travel on the surface of the moon.

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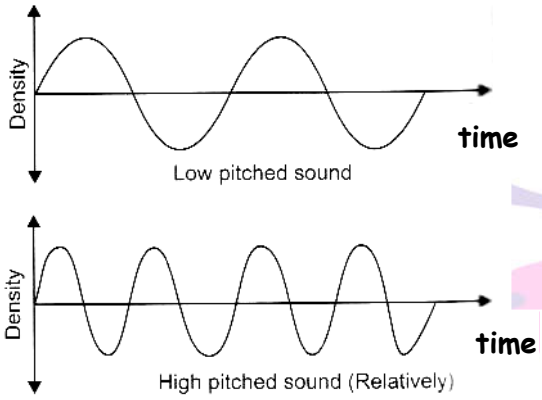
159. a) What are the characteristics of sound waves?

b) An echo is heard after 3s. What is the distance of reflecting surface from the source given that the speed of sound is 342 ms^{-1}

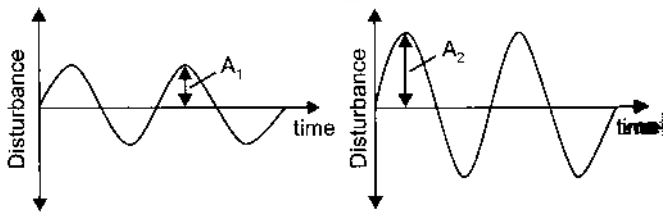
c) What is SONAR? Write its two uses. What are its two main parts?

(a) A sound wave is characterised by its (i) pitch (ii) loudness and (iii) quality.

(i) Pitch is a relative character dependent on frequency of sound wave. More the frequency. More will be the pitch and vice versa. A low pitched sound will have less number of oscillations per unit time than a high pitched sound.



(ii). Loudness or softness is due to the amplitude of the sound. If the amplitude is more, louder will be the sound. Louder sound is caused by the external force of larger magnitude. This is purely relative as 'A sound louder for a person can be mild or soft for



Loudness of first < Loudness of second, $A_1 < A_2$

another.' This depends on intensity which is the amount of energy passing through unit area in one second.

(iii) Quality of sound is a perception used to distinguish the effect of sound in human ear. Two sounds having same loudness and pitch may differ in their quality.

Tone – A sound of single frequency is called a tone.

Note – Series of mixed frequencies produced is called a note

(b) Since t = 3s, v = 342ms^{-1} t = $\frac{2d}{v}$

We get, d = $\frac{vt}{2} = \frac{342 \times 3}{2}$

= 171 x 3 = 513m

(c) **SONAR:** Sound Navigation and Ranging.

Uses:

i) To identify enemy submarines and locate the underwater obstacles on the way.

ii) To test metals for perfection and detect flaws in it.

160. (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?

(a) Moths of certain families have very sensitive hearing equipments. So they can hear the ultrasonic squeaks of a bat flying nearby and are able to escape capture.

(b) The minimum distance in air of the obstacle from the source of sound to hear distinct echoes is 17.2 m

This can be obtained as follows

Speed of sound in air = 344 m/s

Minimum time lag required by ear to hear distinct echo = 0.1s

Total distance travelled by sound [from source to obstacle and then back to ear]

2d = Speed x Time

= 344 x 0.1 = 34.4 m

∴ d = $\frac{34.4}{2} = 17.2m$

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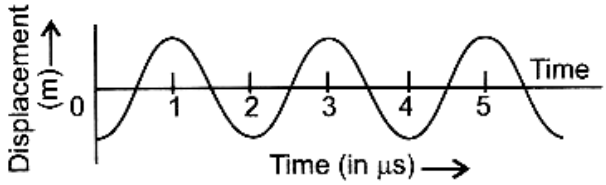
NCERT EXEMPLAR

I. Short answer type question

1. The given graph shows the displacement versus time relation for a disturbance travelling with a velocity of 1500 ms^{-1} . Calculate the wavelength of the disturbance



From The graph, T = 2 x 10^{-6} s,

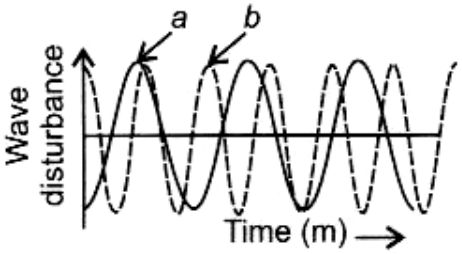
Speed (v) = 1500 ms^{-1}

∴ Wavelength (λ) = v x T

= 1500 x 2 x 10^{-6}

= 3 x 10^{-3} m

2. Which of the below two graphs (a) and (b) representing the human voice is likely to be the male voice ? Give reason for your answer.



Male voice has low pitch (frequency). The frequency of 'b' is less than of 'a'. So, 'b' represents the male voice.

3. Why do we hear the sound produced by the humming bees while the sound of vibrations of pendulum is not heard?

The frequency of oscillations of a pendulum is below the minimum audible value i.e. 20Hz. while the frequency of the sound of the humming bees is in the audible range.

4. If any explosion takes place at the bottom of a lake, what type if shock waves in water will be produced?

Longitudinal waves will be produced

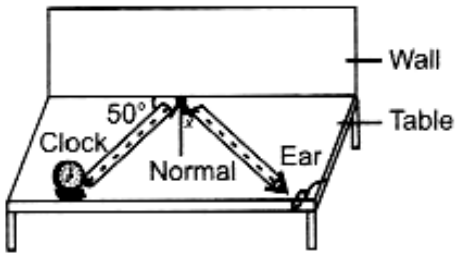
5. The sound produced by a thunderstorm is heard 10s after the lightning is seen. Calculate the approximate distance of the thunder cloud.

(Given speed of sound = 340 ms^{-1}

V = 340 ms^{-1} t = 10s

Distance (d) = Speed (v) x time (t) = 340 x 10 = 3.4 km.

6. For hearing the loudest ticking sound heard by the ear, find the angle x in the figure



The angle $x = 40^0$ as the angle of reflection and incidence are to be equal.

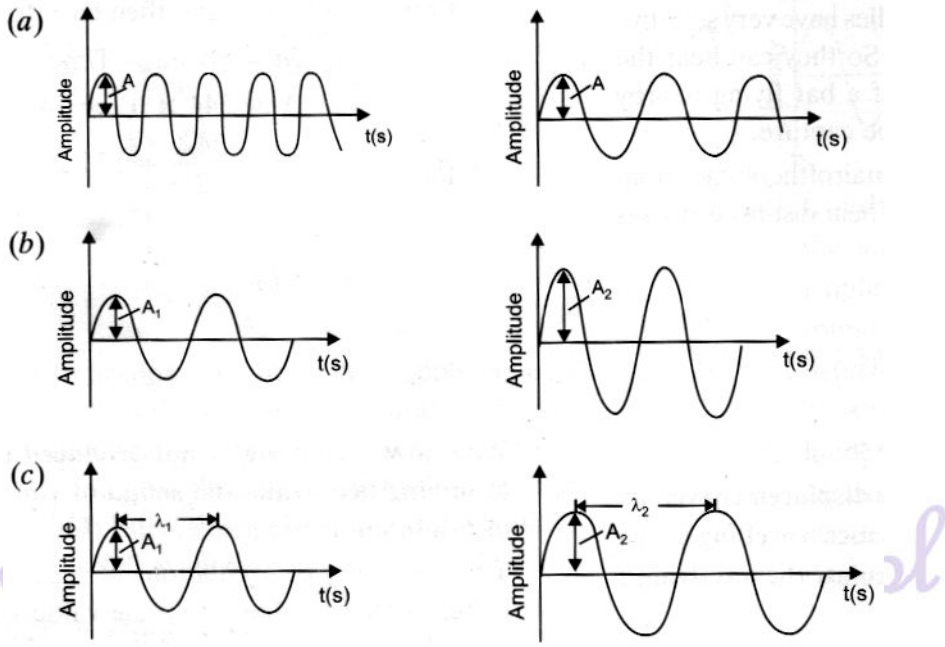
I. Long answer type question

7. Represent graphically by two separate diagrams in each case

a) Two sound waves having the same amplitude but different frequencies

b) Two sound waves having the same frequency but different amplitudes

c) Two sound waves having different amplitudes and also different wavelengths



ated by Pinkz

8. Establish the relationship between speed of sound, its wavelength and frequency. If velocity of sound in air is 340 ms^{-1} calculate

a) wavelength when frequency is 256 Hz

b) frequency when wavelength is 0.85 m

We know that speed of the wave,

$$V = \frac{Length\ travelled}{time\ taken}$$

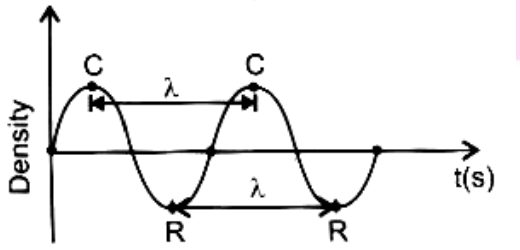
$$\Rightarrow v = \frac{\lambda}{s} = \lambda f \text{ as } f = \frac{1}{T}$$

$$V = 340\ ms^{-1}$$

a) $\lambda = \frac{v}{f} = \frac{340}{256} = 1.33$ m

b) $f = \frac{v}{\lambda} = \frac{340}{0.85} = 400$ Hz.

9. Draw a curve showing density or pressure variations with respect to distance for a disturbance produced by sound. Mark the position of a compression and rarefaction on this curve. Also define wavelength and tune period using this curve



C – Compression (Maximum density)

R – Rarefaction (Minimum density)

Wavelength (λ) is defined as the separtion between two points in the same phase in two consecutive waves, i.e. (C – C) or (R –R)

The time taken for one complete oscillation is called time period, i.e. time for C-C or R-R.

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