CHAPTER 12

Sound

ONE MARK QUESTIONS

1. What do you mean by a wave?

Ans :

A wave is a vibratory disturbance in a medium which carries energy from one point to another without being a direct contact between the two points.

2. What does wave transfer-matter or energy?

Ans :

Energy.

3. Where is density of air higher at compression or at rarefaction?

Ans :

At compression.

4. Guess which sound has a higher pitch-guitar or car horn?

Ans :

Guitar has a higher pitch because it has higher frequency.

5. What is intensity of sound?

Ans :

The amount of sound energy passing through unit area each second is called the intensity of sound.

6. What is relation between time period and frequency?

Ans :

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

7. Name two animals that communicate using infrasound?

Ans :

Rhinoceroses and whales communicate using infrasound.

8. Name the waves used by bats while flying in the dark.

Ans :

Bats use ultrasonic waves while flying in the dark.

9. A Sitarist tries to adjust the tension and pluck the string suitably, before playing the orchestra in a musical concert. By doing so what is he adjusting?

Ans :

He is adjusting frequency if the sitar string with the frequency of the other musical instrument.

10. If the tension in the wire is increased four times, how will the velocity of wave in a string varies?

Ans :

Velocity of the wave in string is directly proportional to the square root of the tension thus if tension is increased 4 times, the velocity will be doubled.

11. A girl claps and hears the echo after reflection from cliff which is 660 m away. If the velocity of sound is 330 ms^{-1}, calculate the time taken for hearing the echo.

Ans :

$$v \times t = 2d$$

$$t = \frac{2d}{v} = \frac{2 \times 660}{330} = 4\,s$$

12. Explain, how is the principle of echo used by the dolphin to locate small fish as its prey?

Ans :

Dolphins are aquatic animals which send out ultrasonic sound to communicate with each other. They have a sound sensing system which enables them to find animals underwater with great accuracy due to the echo of the ultrasonic sound produced by them.

13. Give two practical applications of the reflection of sound waves.

Ans :

(i) In stethoscope the sound of patient's heartbeat reaches the doctor's ears by multiple reflections in the tubes.

(ii) Megaphones are designed to send sound waves in particular direction are based on the reflection of sound.

14. Why are longitudinal waves called pressure waves?

Ans :

Sound waves travels in the form of compression and rarefactions, which involve change in pressure, and volume of the air. Thus, they are called pressure waves.

15. Sound travels faster on a rainy day than on a dry day. Why?

Ans :

Sound travels faster on rainy day because the velocity of sound increases with increase in humidity. On rainy day, humidity is more thus, velocity of sound is also more.

16. How moths of certain families are able to escape capture?

Ans :

Moths of certain families can hear high frequency sounds (squeaks) of bat as they have sensitive hearing equipment. Thus, they get to know when a bat is near by and hence, able to escape its capture.

17. What is SONAR?

Ans :

SONAR (Sound Navigation And Ranging) is a technique for determining water depth and locating underwater objects, such as reefs, submarines and schools of fish.

18. Define one hertz.

Ans :

One hertz is one vibration per second.

19. Define wavelength.

Ans :

It is the distance between two nearest points in a wave which are in the same phase of vibration.

20. What is the audible range of the average human ear?

Ans :

An average human ear can hear sound waves between frequencies 20 Hz to 20,000 Hz.

21. What is sound and how is it produced?

Ans :

Sound is mechanical energy which produces a sensation of hearing. When an object is set into vibrations, sound is produced.

22. Why is sound wave called as longitudinal wave?

Ans :

Sound wave is called longitudinal wave because the particles of the medium vibrate in the direction of the propagation of wave.

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

Ans :

The speed of light is 3×10^8 ms^{-1} whereas that of sound is 344 ms^{-1} in air. Thus, flash of lightning is seen at once, but sound takes few seconds to reach our ears.

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

Ans :

No. of vibrations produced in 1 s = 100
No. of vibrations produced in 60 (sec) = 1 min = $100 \times 60 = 6000$.

25. Name the two types of mechanical waves.

Ans :

The two types of mechanical waves are :
(i) Transverse wave and
(ii) Longitudinal wave.

26. What is a wave?

Ans :

A wave is a disturbance that travels in a medium due to repeated periodic motion of particles about their mean position – such that the disturbance is handed over from one particle to the other without the actual motion of the medium.

27. What is a transverse wave?

Ans :

It is a wave in which the particles of the medium vibrate perpendicular to the direction of propagation of the wave.

28. What is a longitudinal wave?

Ans :

It is a wave in which the particles of the medium vibrate in the direction of propagation of the wave.

29. What is a trough?

Ans :

A trough is a depression in a wave, i.e., maximum displacement in the negative direction (below the mean position).

30. What do you understand by the term infrasonic vibrations?

Ans :

The sounds of frequency lower than 20 Hz are called the infrasonics or subsonics.

31. Which of the following sound waves we can hear : 10 Hz, 500 Hz, 1500 Hz, 12000 Hz, 25000 Hz?

Ans :

500 Hz, 1500 Hz, 12000 Hz.

32. What do you understand by the term ultrasonic vibrations?

Ans :

Sounds of frequency higher than 20,000 Hz are called the ultrasonics.

33. What do you understand by the term echo?

Ans :

The sound heard after reflection from a rigid obstacle is called an echo.

34. Name the term associated with the travelling disturbance in a medium.

Ans :

Wave.

35. Do waves transport energy?

Ans :

Yes.

36. Do waves transport matter?

Ans :

No.

37. Do the particles of the medium move from one place to another in a medium?

Ans :

No.

38. Does the velocity of wave motion depend on the nature of the medium?

Ans :

Yes.

39. Does the velocity of wave motion depend on the nature or motion of the source?

Ans :

No.

40. What is the other name of a long flexible spring?

Ans :

Slinky is the other name of a long flexible spring.

41. Can you produce both types of waves (i.e., longitudinal and transverse) on a slinky?

Ans :

Yes, we can produce both types of waves (i.e., longitudinal and transverse) on a slinky.

42. Where is the density of air higher; at compressions or at rarefactions?

Ans :

At the compression the density of air is higher.

43. Name the quantity that represents the length of one complete wave.

Ans :

Wavelength represents the length of one complete wave.

44. What is the distance between two consecutive crests in a wave called?

Ans :

Wavelength is the distance between two consecutive crests in a wave.

45. Is the amplitude of a wave the same, as the amplitude of the vibrating body producing the wave?

Ans :

Yes, the amplitude of a wave is same, as the amplitude of the vibrating body producing the wave.

46. What is the range of frequencies associated with :
(a) Infrasound
(b) Ultrasound

Ans :

(a) **Infrasound :** Sound waves between the frequencies 1 to 20 Hz.
(b) **Ultrasound :** Sound waves of the frequencies above 20,000 Hz.

THREE MARKS QUESTIONS

47. Give difference between loudness and intensity of the sound.

Ans :

	Loudness	Intensity
1.	Loudness is a measure of the response of our ear to the sound.	It is the energy per second per unit area normal to the direction of energy flow.
2.	It depends on intensity as well as sensitivity of the ear. Therefore, it is not absolute but relative.	It does not depend upon the sensitivity of the ear.
3.	The unit of loudness is decibel.	The unit of intensity is watt/m^2.

48. What are transverse waves? Give two examples.

Ans :

A wave in which the particles of the medium vibrate up and down at right angle to the direction in which the wave is moving.
Example :
(i) The waves produced by moving one end of a long spring up and down rapidly.
(ii) Ripples formed on the surface of water in a pond.

49. What are crests and troughs of a wave?

Ans :

The elevation in a transverse wave is called crest. It is that part of transverse wave which s above the line of zero disturbance of the medium. The depression in a transverse wave is called trough. It is that part of the transverse wave which is below the line of zero disturbances.

50. What is a stethoscope? Name the principle on which a stethoscope works.

Ans :

Stethoscope is a medical instrument used for listening

sounds produced within the body, chiefly in the heart or lungs. Stethoscope works on the principle of multiple reflection of sound.

51. How moths of certain families are able to escape captures from bats? What is the range of frequencies associated with :
(a) infrasound?
(b) ultrasound?

Ans :

They have very sensitive hearing equipment, that can hear the squeaks (ultrasound) of bat and know when a bat is flying nearby.
(a) Less than 20 Hz.
(b) More than 20,000 Hz.

52. A person fires a gun standing at a distance of 55 m from a wall. If the speed of sound is 330 ms^{-1}, find the time for an echo to be heard.

Ans :

Given $d = 55$ m, $v = 330$ ms^{-1}, $t = ?$

$$2d = v \times t$$

or $$t = \frac{2d}{v} = \frac{2 \times 55}{330} = 0.3\,s$$

53. The pulse rate of a man is 80 beats in one minute. Calculate its frequency.

Ans :

No. of beats per minute = 80

No. of beats per second = $= \frac{80}{60} = 1.3$

So, frequency = 1.3 Hz

54. What is echo? Explain the conditions that have to be satisfied to hear an echo?

Ans :

Reflection of sound wave from a large obstacle is called an echo. The most important condition for hearing an echo is that the reflected sound should reach the ear only after a lapse of at least 0.1 second after the original sound is off and the obstacle is at least at a distance of 17 m.

55. Why do echoes produced in an empty auditorium usually decrease when it is full of audience?

Ans :

When the hall is empty there are no obstacles in between to reflect the sound other than the walls. When the hall is full of audiences, the sound produced undergoes multiple reflections from the people and so it overlaps with the sound produced. Hence, the listener is not able to distinguish between the original sound and the echo.

56. Which wave property determines :
(i) loudness (ii) pitch

Ans :

(i) The amplitude of the wave determines the loudness. More the amplitude of a wave, more is the loudness produced.
(ii) The pitch is determined by the frequency of the wave. Higher the frequency of a wave, more is its pitch and shriller is the sound.

57. When a sound is reflected from a distant object, an echo is produced. Let the distance between the reflecting surface and the source of sound production remains the same. Do you hear echo sound on a hotter day?

Ans :

If the temperature rises, the speed of sound will increase. This in turn will increase the minimum distance required for hearing an echo. No echo is heard because the distance between the source of sound and reflecting body does not increase.

58. Explain, why can echoes not be heard in a small room?

Ans :

For hearing echo, there should be at least a distance of 17 m between the source of sound and the body from which sound is reflected. In small rooms this is not the case, hence, echoes are not heard.

59. Sound is produced due to a vibratory motion, then why a vibrating pendulum does not produce sound?

Ans :

The frequency of the vibrating pendulum does not lie within the audible range (20 Hz to 20,000 Hz) and hence, it does not produce audible sound.

60. Distinguish between transverse and longitudinal waves (three points).

Ans :

Transverse waves :
(i) Particles the medium vibrate at right angles.
(ii) Alternate crests and troughs formed.
(iii) e.g., water waves.

Longitudinal waves :
(i) Particles vibrate parallel to the direction of waves.
(ii) Alternate compressions, rarefaction formed.
(iii) e.g., sound waves.

61. State three characteristics of a musical sound. On what factors do they depend?

Ans :

Characteristics of musical sound are :
(i) Loudness–Amplitude affects loudness–more amplitude, louder the sound and lesser the amplitude, softer is the sound.
(ii) Pitch-Frequency affects pitch-more frequency more pitch, less frequency less pitch.
(iii) Quality.

62. How does the sound produced by a musical instrument, reach your ears? Astronauts need radio transmitter to talk to each other on Moon. Why?

Ans :

The sound produced by the musical instrument makes the molecules of air vibrate. These vibrations are carried forward by the other molecules till they reach our ear. These then vibrate our eardrum to produce sound. Since, sound requires a medium to propagate, therefore, sound cannot travel between astronauts on the Moon, hence, they use radio transmitters.

63. What are wavelength, frequency, time period and amplitude of a sound wave?

Ans :

Wavelength : It is the linear distance between two consecutive compressions or two consecutive rarefactions.
Frequency : The number of compressions or rarefactions taken together passing through a point in one second is called frequency.
Time period : It is the time taken by two consecutive compressions or rarefactions to cross a point.
Amplitude : It is the magnitude of maximum displacement of a vibrating particle about its mean position.

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

Ans :

Yes, sound and light follow the same laws of reflection that are given below :
(a) Angle of incidence at the point of incidence = Angle of reflection. ($\angle i = \angle r$)
(b) At the point of incidence, the incident sound wave, the normal and the reflected sound wave lie in the same plane.

65. What are longitudinal waves? Give two examples.

Ans :

A wave in which the particles of the medium vibrate back and forth along the same direction, in which the wave is moving, is called a longitudinal wave.
Examples :
(a) The sound waves in air.
(b) The waves produced in air when a sitar wire is plucked.

66. Distinguish between tone and note.

Ans :

A pitch is a particular frequency of sound, for example : 440 Hz.
A note is a named pitch. For example : Western music generally refers to the 440 Hz pitch as A, specifically A4.

67. How do you account for the fact that two strings can be used to give notes of the same pitch and loudness but of different quality?

Ans :

The 'quality' of a given note is determined by the overall effect of the harmonics present in it. The harmonics are multiples of the fundamental or basic frequency of the 'note'. Depending on the conditions under which vibrations are taking place, sometimes we get one set of harmonics and sometimes another set. The quality of the two notes will, therefore, different even though their fundamental frequencies may be the same.

68. State any two characteristics of a wave motion.

Ans :

The characteristics of wave motion are :
(i) It is a periodic disturbance.
(ii) Energy transfer takes place at a constant speed.

69. A longitudinal wave of wavelength 1 cm travels in air with a speed of 330 ms^{-1}. Calculate the frequency of the wave. Can this wave be heard by a normal human being?

Ans :

Given $\lambda = 1$ cm $= 0.01$ m

$$v = 330 \text{ ms}^{-1}$$

Using $v = \nu\lambda$ we have

$$\nu = \frac{v}{\lambda} = \frac{330}{0.01} = 33000 \text{ Hz}$$

No, this cannot be heard by a normal human being.

70. If the amplitude of a wave is doubled, what will be the effect on its loudness?

Ans :

Loudness depends upon the square of the amplitude of the wave, therefore, when the amplitude of wave is doubled, the loudness becomes four times.

71. How do the frequency and amplitudes affect a musical sound?

Ans :

The 'frequency' of a musical sound affects its 'pitch'. The more the frequency of a (musical) sound, the 'sharper' and 'shriller' the sound becomes.

The 'amplitude' of a musical sound affects its loudness, or intensity. The more the amplitude of the sound, the louder (or more intense) the sound is.

72. Give one example each of natural vibration, forced vibration and resonance.

Ans :

(i) **Natural vibration :** The vibrations of a simple pendulum about its mean position.
(ii) **Forced vibration :** A sonometer wire, under tension, vibrating under the influence of a vibrating tuning fork.
(iii) **Resonance :** A correctly adjusted length of a sonometer wire under proper tension, vibrating under the influence of a vibrating tuning fork.

73. Mention one practical use of echoes.

Ans :

Echoes are used in radars to estimate the distance of flying objects.

74. How does a stretched string on being set into vibration, produce the audible sound?

Ans :

On being set into vibrations, the stretched string, forces the surrounding air to vibrate. This vibrating air, in turn, affects our eardrum and produces an audible sound.

75. Will the sound be audible if the string is set into vibration on the surface of the Moon? Give reason for your answer.

Ans :

No, we will not hear any audible sound on the surface of the Moon. This is because sound requires a medium to propagate, since there is no atmosphere on the surface of Moon, therefore, the sound will not be heard.

76. What change, if any, would you expect in the characteristics of musical sound when we increase :
(i) its frequency, and
(ii) its amplitude?

Ans :

(i) Pitch of sound will increases,
(ii) Loudness of sound will increases.

FIVE MARKS QUESTIONS

77. (i) Draw the sound waves for a low pitched and the high pitched sound.
(ii) Write one use of ultrasonography.
(ii) Which wave property determines pitch?

Ans :

(i) The diagram is as shown :

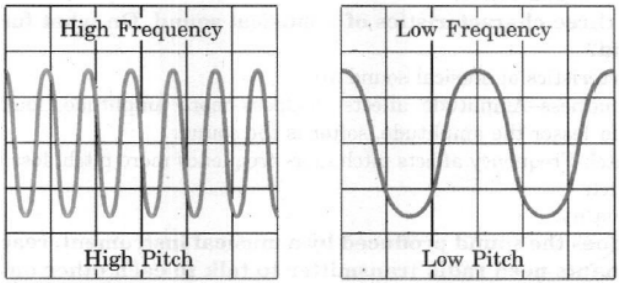


Figure: Frequency of sound wave

(ii) Ultrasonography is used for examination of the fetus during pregnancy to detect congenital defects and growth abnormalities.
(iii) The pitch depends on frequency.

78. The stem of a tuning fork is pressed against a table top. Answer the following questions :
(i) Would the above action produce any audible sound?
(ii) Does the above action cause the table to set into vibrations?
(iii) If the answer above is yes, what type of vibrations are they?
(iv) Under what conditions does the above action lead to resonance?

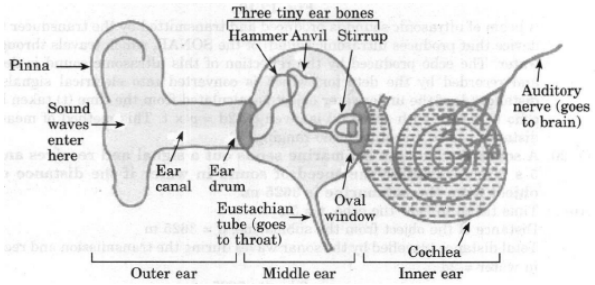
Ans :

(i) Yes, there is an audible sound produced.
(ii) Yes, the table top is set into 'forced vibrations' by this.
(iii) The vibrations are forced vibrations.
(iv) Pressing the stem of a vibrating tuning fork against a table top, would lead to resonance if the frequency of the tuning fork equals the natural frequency of oscillations of the table top.

79. How does the sound produced by a vibrating object in a medium reach your ear?

Ans :

When a vibrating object moves forward, it pushes and compresses the air in front of it creating a region of high pressure called compression. This compression starts to move away from the vibrating object. When vibrating object moves backwards, it creates a region of low pressure called refraction. As the object moves forth and back rapidly, a series of compressions and refractions are created in the air. These produce the sound wave that propagates through the medium. This continues until the sound wave reaches to the ear of the listener.



80. Write conditions for the production of an echo.

Ans :

Conditions for the production of an echo are :
(i) Time gap between the original sound and the reflected sound.
The echo will be heard if the original sound reflected by an obstacle reaches our ears after 0.1 s.
(ii) Distance between the source of sound and obstacle. Thus, the minimum distance (in air at 25°C) between the observer and the obstacle for the echo to be heard clearly should be 17.2 m.
(iii) Nature of the obstacle : For the formation of an echo, the reflecting surface or the obstacle must be rigid such as a building, hill or a cliff.
(iv) Size of the obstacle : Echoes can be produced if the size of the obstacle reflecting the sound is quite large.

81. With the help of a labelled diagram show that sound needs a material medium for its propagation.

Ans :

A well labelled diagram is as shown :

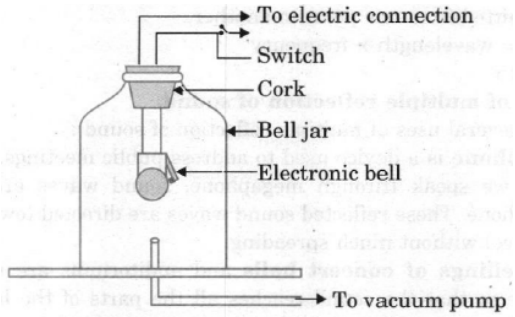


Figure: Bell jar experiment

(i) Take an electric circuit which consists of a cell, a switch and an electric bell arranged inside a bell jar, which stands on the platform of an evacuating pump.
(ii) The switch of the bell is pressed to close the electric circuit. When there is air within the bell jar, sound is heard. Air is now pumped out of the bell jar. When the air is completely removed from the bell jar, no sound is heard as it is obvious from fig. because the medium of air which has to carry energy from the bell to the bell jar is removed. It shows that sound needs material medium for its propagation.

82. A particular transmitter of Aakashvani broadcasts at 420.5 m wavelength. (Given the speed of radio waves 3×10^8 ms^{-1}) Calculate the frequency at which the radio station broadcasts its program. What is the direction of oscillations of the medium particles through which a :
(i) Transverse wave is propagating?
(ii) Longitudinal wave is propagating?

Ans :

Given

$$\lambda = 420.5 \text{ m}, v = 3 \times 10^8 \text{ ms}^{-1}, \nu = ?$$

Using the expression $v = \nu\lambda$

$$\nu = \frac{v}{\lambda} = \frac{3 \times 10^8}{420.5}$$

$$= 7 \times 10^5 \text{ Hz}$$

(i) The particles oscillate perpendicular to the direction of propagation of the wave.
(ii) The particles oscillate parallel to the direction of propagation of the wave.

83. (i) State two characteristics of wave motion.
(ii) What is the relation between frequency, wavelength and speed of a wave?

Ans :

(i) A wave motion is periodic in nature. The particles of the medium do not move from their mean position but execute vibration but only the energy is transmitted from one point to another.
(ii) Speed = wavelength × frequency

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

84. Give uses of multiple reflection of sound.

Ans :

There are several uses of multiple reflection of sound :
(i) Megaphone is a device used to address public meetings. It is horn-shaped. When we speak through megaphone, sound waves are reflected by the megaphone. These reflected sound waves are directed towards the people (or audience) without much spreading.
(ii) The ceilings of concert halls and auditoriums are made curved. This is done so that the sound reaches all the parts of the hall after reflecting from the ceiling. Moreover, these ceilings are made up of sound absorbing materials to reduce the reverberation.
(iii) Stethoscope is a device used by doctors to listen the sound produced by heart and lungs. The sound produced by heart beat and lungs of a patient reaches the ears of a doctor due to multiple reflection of sound.
(iv) Sound boards are curved surfaces (concave) which are used in a big hall to direct the sound waves towards the people sitting in a hall. The speaker is (i.e., source of sound) placed at the focus of the sound board.
(v) Sound waves from the speaker are reflected by die sound board and these reflected waves are directed towards the people (or audience).
(vi) Hearing aid is used by a person who is hard of hearing. The sound waves falling on hearing aid are concentrated into a narrow beam of sound waves by reflection. This narrow beam of sound waves is made to fall on the diaphragm of the ear. Thus, diaphragm of the ear vibrates with large amplitude. Hence, the hearing power of the person is improved.

85. Give application of ultrasound (ultrasonic waves).

Ans :

Ultrasonic waves have number of uses :
(1) Ultrasonic vibrations are used for homogenising milk. These vibrations break down the larger particles of the fat present in milk to smaller particles.
(2) Ultrasonic vibrations are used in dish washing machines. The vibrating detergent particles rub against the dirty utensils and thus, clean them.
(3) Ultrasonic vibrations produce a sort of depression in rats and cockroaches.
(4) Ultrasonic vibrations are used to study the growth of foetus in mother's womb.
(5) Ultrasonic vibrations are used in relieving pain in joints and muscles.
(6) Ultrasonic vibrations are used in detecting flaws in articles made from metals. They are also used in finding the thickness of various parts of a metallic component.

NUMERICAL QUESTIONS

86. A tuning fork produces 1024 waves in 4 seconds. Calculate the frequency to the tuning fork.

Ans :

As the tuning fork produces 1024 waves in 4 seconds, hence
Frequency of tuning fork,

$$\nu = \text{Number of vibration per second}$$
$$= \frac{1024}{4} = 256 \text{ Hz}$$

87. A human heart, on an average, is found to beat 75 times a minute. Calculate its frequency.

Ans :

$$\text{No. of beats of human heart} = 75 \text{ min}^{-1}$$
$$= \frac{75}{1} \text{ min}$$
$$= \frac{75}{60} \text{ s} = 1.25 \text{ s}^{-1}$$

So, average frequency of human heart beating $= 1.25 \text{ s}^{-1}$.

88. A boat at anchor is rocked by waves whose consecutive crests are 100 m apart. The wave velocity of the moving crests is 20 m/s. What is the frequency of rocking of the boat?

Ans :

Distance between two consecutive crests = 100 m
Wave velocity v = 20 m/s
The distance between two consecutive crests is equal to the wavelength of the wave. So,

$$\text{Frequency} = \frac{\text{Wave velocity}}{\text{Wave length}}$$
$$= \frac{20 \text{ m s}^{-1}}{100 \text{ m}} = 0.2 \text{ s}^{-1}$$

So, the frequency of rocking of the boat is 0.2 s^{-1}.

89. A longitudinal wave is produced on a toy slinky. The wave travels at a speed of 30 cm/s and the frequency of the wave is 20 Hz. What is the minimum separation between the consecutive compressions of the slinky?

Ans :

Wave speed, $\nu = 30$ cm/s
Frequency of the wave, $\nu = 20 \text{ Hz} = 20 \text{ s}^{-1}$
The minimum separation between the consecutive compressions is equal to the wavelength. Therefore,

$$\text{Wavelength} = \frac{30 \text{ cm s}^{-1}}{20 \text{ s}^{-1}} = 1.5 \text{ cm}$$

Thus, the minimum separation between the consecutive compression of the slinky is 1.5 cm.

90. A bat can hear sound at frequencies up to 120 kHz. Determine the wavelength of sound in the air at this frequency. Take the speed of sound in the air as 344 m/s.

Ans :

Frequency, $\nu = 120 \text{ kHz} = 120 \times 10^3 \text{ Hz}$
$= 120 \times 10^3 \text{ s}^{-1}$

Velocity of sound in the air, $v = 344$ m/s
Wavelength of the sound wave = λ
We know,

$$\text{Wavelength,} \quad \lambda = \frac{\text{wave velocity}}{\text{frequency}}$$
$$= \frac{344 \text{ ms}^{-1}}{120 \times 10^3 \text{ s}^{-1}}$$
$$= 2.87 \times 10^{-3} \text{ m} = 0.29 \text{ cm}$$

91. A gun is fired in the air at a distance of 660 m, from a person. He hears the sound of the gun after 2 s. What is the speed of sound?

Ans :

Distance travelled by sound = 660 m,
Time taken by the sound = 2 s,
Speed of sound in air = ?

$$\text{So,} \quad \text{Speed of sound} = \frac{\text{Distance}}{\text{Time}}$$
$$= \frac{660 \text{ m}}{2 \text{ s}} = 330 \text{ m/s}$$

Thus, the speed of sound in the air is 330 m/s.

92. A child hears an echo from a cliff 4 seconds after the sound from a powerful cracker is produced. How far away is the cliff from the child? Velocity of sound in air at 20°C is 344 m/s.

Ans :

Let the distance between the child and the cliff be d. Then,
Total distance travelled by the sound = 2d
Total time taken by the sound = 4 s

$$\text{Then,} \quad \text{Velocity of sound} = 344 \text{ m/s} = \frac{d}{2s}$$

$$\text{This gives,} \quad d = 344 \text{ m/s} \times 2 \text{ s}$$
$$= 688 \text{ m}$$

Thus, the cliff is at a distance of 688 m from the child.

93. A ship sends on a high frequency sound wave and receives an echo after 1 second. What is the depth of the sea? Speed of sound in water is 1500 m/s.

Ans :

Let, Depth of the sea = d
So, total distance travelled by the sound wave = 2d
Time taken by sound to travel both ways = 1s
As per definition,

$$\text{Speed of the sound} = 1500 \text{ ms}^{-1} = \frac{2d}{1s}$$

$$\text{or} \quad d = 1500 \text{ ms}^{-1} \times \frac{1s}{2} = 750 \text{ m}$$

Thus, the depth of the sea is 750 metres.

94. A sonar echo takes 2.2 s to return from a whale. How far away is the whale?

Ans :

Total time taken by the signal = 2.2 s
So, time taken the signal to reach the whale = 1.1 s
Distance of the whale = d (assume)
Speed of sound in sea water at 25°C = 1533 ms^{-1}

So, distance of the whale,

$$d = \text{Speed of the signal} \times \text{Time taken}$$

or $$d = 1533 \text{ m s}^{-1} \times 1.1 \text{ s} = 1686.3 \text{ m}$$

95. Using the SONAR, sound pulses are emitted at the surface of water. These pulses after being reflected from the bottom are detected. If the time interval from the emission to the detection of the sound pulses is 2 seconds, find the depth of the water. Velocity of sound in water = 1498 m/s.

Ans :

Let, depth of the water from the Earth's surface be d. Then,
Total distance travelled by the pulse = 2d
Total time taken by the pulse = 2s
As per definition,

$$\text{Velocity} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

So, $$\text{Velocity of the sound} = \frac{2d}{2s} = \frac{d}{s}$$

$$1498 \text{ m/s} = \frac{d}{s}$$

This gives, $$d = 1498 \text{ m/s} \times 1\text{s}$$
$$= 1498 \text{ m}$$

Thus, the depth of water is 1498 m.

96. A wave moves a distance of 8 m in 0.05 s :
(a) Find the velocity of the wave.
(b) What is the wavelength of the wave if its frequency is 200 Hz?

Ans :

(a) $$\text{Velocity} = \frac{8}{0.05} = 160 \text{ ms}^{-1}$$

(b) $$\lambda = \frac{160}{200} = 0.8 \text{ m}$$

97. A stone is dropped into a well 44.1 m deep. The splash is heard 3.13 seconds after the stone is dropped. Find the velocity of sound in air.

Ans :

Stone falling from A to B

$$u = 0, s = 44.1 \text{ m}, g = 9.8 \text{ ms}^{-2}, t = ?$$

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

$$44.1 = \frac{1}{2} \times 9.8 \times t^2$$

$$t = 3 \text{ s}$$

Sound produced at B, due to sound produced by the stone falling on the surface of water, travels from B to A. The sound moves with constant velocity.

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

$$v = \frac{44.1}{t'}$$

$$t' = \frac{44.1}{v}$$

It is given that the total time is 3.13 second.

i.e. $$t + t' = 3.13$$

$$3 + \frac{44.1}{v} = 3.13$$

$$\frac{44.1}{v} = 0.13$$

$$v = 339.2 \text{ ms}^{-1}$$

98. Using sonar, sound pulses are emitted at the surface of water. These pulses after being reflected from water bottom are detected. If the time interval from the emission to the detection of the sound pulses is 2 seconds, find the depth of the water. (speed of sound in water = 1531 m/s given)

Ans :

$$t = 2 \text{ s}$$

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

$$1531 = \frac{2x}{2}$$

$$x = 1531 \text{ m}$$

99. Calculate (a) the wavelength (b) the time period of a tuning fork of frequency 512 Hz which is set to vibrate. Velocity of sound in air is 320 m/s.

Ans :

$$\text{Frequency of the tuning fork } (\nu) = 512 \text{ Hz}$$

$$\text{Velocity of sound } (v) = 320 \text{ m/s}$$

$$\text{Wavelength } (\lambda) = \frac{v}{\nu} = \frac{320}{512}$$

$$= 0.625$$

$$\text{time period (t)} = \frac{1}{v}$$

$$= 0.00195 \text{ s}$$

100. Sound waves travel with a speed of 330 m/s. What is the wavelength of sound, whose frequency is 550 Hz?

Ans :

Speed of the sound wave (v) = 330 m/s
Frequency of the sound wave (ν) = 550 Hz

$$\text{Wavelength } (\lambda) = \frac{v}{\nu} = \frac{330}{550} = \frac{33}{55}$$

$$\text{Wavelength} = 0.6 \text{ m}$$

101. Derive a relation between wave-velocity, frequency and wavelength.

Ans :

Wave velocity is defined as the distance travelled by the wave in one second.

$$\text{Wave velocity} = \frac{\text{Distance travelled by one wave}}{\text{Time taken by one wave}}$$

$$= \frac{\text{Wavelength}}{\text{Time}}$$

But $$\frac{1}{t} = v$$

So, $$\text{Wave velocity} = \text{Wavelength} \times \text{Frequency}$$

102. Radiowaves of speed 3×10^8 m s^{-1} are reflected off the Moon and received back on Earth. The time elapsed between the sending of the signal and receiving it back at the Earth station is 2.5 s. What is the distance of the Moon from the Earth?

Ans :

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

$$= \frac{3 \times 10^8 \times 2.5}{2}$$

$$= \frac{7.5 \times 10^8}{2} = 3.75 \times 10^8 \text{ m}$$

103. (a) A sound wave of wave length 0.33 m has a time period of 10^{-3} s. If the time period is decreased to 10^{-4} s, calculate the wave length and frequency of the new wave.

(b) Name the subjective property of sound related to its frequency and of light related to its wavelength.

Ans :

(a) $\lambda = 0.33$ m

Time taken to travel λ, $t = 10^{-3}$

$$\text{velocity} = \frac{\lambda}{t} = \frac{0.33}{10^{-3}} = 300 \text{ m s}^{-1}$$

Time period of 2nd wave $= 10^{-4}$ s

Therefore, wavelength $\lambda = v \times t$

$$= 330 \times 10^{-4} = 0.033 \text{ m}$$

$$\text{Frequency} = \frac{1}{t} = \frac{1}{10^{-3}} = 10^3 \text{ Hz}$$

(b) Pitch is related to the frequency of sound and colour is related to the wavelength of light.

104. A longitudinal wave of wavelength 1 cm travels in air with a speed of 330 ms^{-1}. Calculate the frequency of the wave. Can this wave be heard by a normal human being?

Ans :

$$v = \nu\lambda$$

$$\nu = \frac{v}{\lambda} = \frac{330}{0.01} = 33{,}000 \text{ Hz}$$

The sound is not audible to human ear because frequency 20 to 20,000 Hz is the audible range of human ear.

105. A person standing between two vertical cliffs and 640 m away from the nearest cliff shouted. He heard the 1st echo after 4 seconds and the second echo 3 seconds later. Calculate : (i) the velocity of sound in air and (ii) the distance between the cliff.

Ans :

$$\text{Velocity of sound } (v) = \frac{2d}{t} = \frac{2 \times 640}{4} = 320 \text{ m s}^{-1}$$

Distance the farthest cliff,

$$d = \frac{v \times t}{2} = \frac{320 \times 7}{2} = 1120 \text{ m}$$

Therefore the distance between the cliffs,

$$D = 640 + 1120 = 1760 \text{ m}$$

106. A ship on the surface of water sends a signal and receives it back after 4 seconds from a submarine inside the water. Calculate the distance of the submarine from the ship (The speed of sound in water is 1450 m s^{-1}).

Ans :

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

$$d = \frac{v \times t}{2} = \frac{1450 \times 4}{2}$$

$$= 2900 \text{ m or } 2.9 \text{ km}$$

107. A man fires a gun and hears its echo after 5 seconds. The man then moves 310 m towards the hill and fires his gun again. This time he hears the echo after 3 seconds. Calculate the speed of sound.

Ans :

Let d be the distance between the man and the hill in the beginning.

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

$$= \frac{2d}{5} \quad .....(1)$$

He moves 310 m towards the hill. Therefore, the distance will be (d – 310) m.

$$v = \frac{2(d-310)}{3} \quad .....(2)$$

Since, velocity of sound is same, equating (1) and (2), we get

$$\frac{2d}{5} = \frac{2(d-310)}{3}$$

$$3d = 5d - 1550$$

$$2d = 1550$$

$$d = 775 \text{ m}$$

$$\text{Velocity of sound } (v) = \frac{2 \times 775}{5}$$

$$= 310 \text{ m s}^{-1}$$

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Science IX

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NCERT_Text_5	NCERT_Sol_5	Objective_5	Ques_Bank_5
NCERT_Text_6	NCERT_Sol_6	Objective_6	Ques_Bank_6
NCERT_Text_7	NCERT_Sol_7	Objective_7	Ques_Bank_7
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