Assignments in Science Class IX (Term II)

12 Sound

IMPORTANT NOTES

1. Sound is a mechanical energy which produces sensation of hearing.

2. For hearing sound there must be (i) a vibrating body, (ii) a material medium for its propagation and (iii) a receiver, such as human ear.

3. Sound energy does not propagate through vacuum.

4. When the particles of a medium oscillate in the same direction, in which wave is being propagated, such a wave is called **longitudinal wave**.

5. When the particles of a medium oscillate at right angles to the direction of wave propagation, a transverse wave is produced.

6. Transverse waves can be produced in solids and liquids, but not in gases.

7. The highest point on the elevation or hump of a transverse wave is called **crest**.

8. The lowest point on the depression or hollow of a transverse wave is called **trough**.

9. Compression is a region in a longitudinal wave, where the particles of medium are crowded together. It is a region of high pressure and high density.

10. Rarefaction is a region in a longitudinal wave, where the particles of medium are spread wide apart. It is a region of low pressure and low density.

11. The change in density of a medium from maximum value to minimum value and again to maximum value in case of longitudinal wave is called one **oscillation**.

12. The number of compressions and rarefactions (taken together) passing through a point in one second is called **frequency**. Its unit is hertz.

13. The time taken by two consecutive compressions or rarefactions to cross a point is called **time period**.

14. The magnitude of maximum displacement of a vibrating particle about its mean position is called **amplitude**.

15. The pitch of sound is determined by its frequency, *i.e.*, higher the frequency, more is the pitch and hence, shriller is the sound.

16. The loudness of sound is determined by the amplitude, *i.e.*, more the amplitude, louder is the sound.

17. The property by virtue of which the note of same pitch and same frequency can be distinguished is called **timbre** or **quality of sound**.

18. Sound travels fastest in solids, slower in liquids and slowest in gases.

19. A conical tube commonly used for addressing a small group of people is called **megaphone**.

20. The phenomenon due to which repetition of sound is heard after reflection from a distant object, after the original sound from a given source dies is called an **echo**.

21. For hearing an echo, the minimum distance between the source of sound and reflecting body should be 17m.

22. Vibrations within the frequency range of 0 Hz to 20 Hz are called infrasonic vibrations. Humans cannot hear them.

23. Vibrations within the frequency range of 20 Hz to 20000 Hz are called sonic vibrations. They can be heard by humans.

24. Vibrations above the frequency range of 20,000 Hz known as ultrasonic vibrations. Humans cannot hear them.

25. A device used to locate depth of sea or submarines, etc, is called **sonar**.

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ASSIGNMENTS FOR SUMMATIVE ASSESSMENT

I. VERY SHORT ANSWER QUESTIONS (1 Mark)

PREVIOUS YEARS' QUESTIONS

1. What is reverberation? **[2011 (T-II)]**
2. Name the disease that can be caused by UV rays. **[2011 (T-II)]**
3. If 20 waves are produced per second, what is the frequency in hertz? **[2011 (T-II)]**

OTHER IMPORTANT QUESTIONS

1. What do you understand by the term wave motion?
2. What do you understand by the term sound energy?
3. What kind of elastic wave is produced when the particles of a medium vibrate at right angles to the direction of sound propagation?
4. What kind of wave is produced when the particles of a medium vibrate in the direction of propagation of sound?
5. The frequency of a sound wave is 32 Hz. What is the time period?
6. A vibrating wire has a time period 0.025 s, calculate the frequency.
7. What is the linear distance between a crest and a trough?
8. The frequency produced by a tuning fork is 41.5 Hz. What is the distance travelled by sound when the tuning fork makes 20 vibrations?
9. What is the amount of sound energy passing per second through unit area known as?
10. If a sound wave travels in air and steel with a speed X m/s and Y m/s respectively, find the ratio of the time taken by the sound waves in air and steel to reach a certain point?
11. Give the relation between wavelenght (λ), velocity (v) and frequency (f).
12. What is the speed of sound in air at 0 °C?
13. How are echoes produced?
14. The frequency of a sound wave in air is 128 Hz. What will be its frequency in water?
15. A girl hears an echo of her own voice from a distant tall building after 2s. What is the distance of the girl from the building? (Given speed of sound in air = 332 m/s)
16. A source wave produces 20 compressions and 20 rarefactions in 0.045 seconds. What will be the frequency of the wave?
17. An elephant can hear a sound of frequency 16 Hz. What is the wavelength of sound in air at this frequency? [Given, speed of sound in air = 320 m/s]
18. A tuning fork produces 1024 oscillations in 4s. What is the frequency of the tuning fork?
19. What do you mean by bass in a musical sound?
20. What kind of waves are used in sonography?

II. SHORT ANSWER QUESTIONS - I (2 Marks)

PREVIOUS YEARS' QUESTIONS

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

Persons	Mediums
A	Iron Rod
B	Air
C	Water

Who will hear the sound first? Why? **[2011 (T-II)]**

2. (i) Define the time period of a wave.

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

(iii) A sound wave travels at a speed of 339 ms^{-1}. If its wavelength is 1.5 cm, what is the frequency of the wave? **[2011 (T-II)]**

3. Draw a neat labelled structure of human ear, depicting the auditory parts only. **[2011 (T-II)]**
4. 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

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1.7 km/s. The operating frequency of the scanner is 4.2 MHz (1MHz =10^6 Hz). **[2011 (T-II)]**

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

[2011 (T-II)]

6. 20 waves pass through a point in 2 seconds. If the distance between one crest and adjacent thorough is 1.5 m. Calculate :

(a) the frequency

(b) the wavelength **[2011 (T-II)]**

7. What is meant by reverberation of sound? Does reverberation produce undesirable effects in big hall or auditorium? If yes, how are the undesirable effects avoided? **[2011 (T-II)]**

8. What is echo ranging? State any one application of this technique. **[2011 (T-II)]**

9. A person is listening to a tone of 500 Hz sitting at a distance of 450 m from the source of the sound. Calculate the time interval between successive compressions from the source? (Speed of sound in air = 330 m/s) **[2011 (T-II)]**

10. Differentiate between low and high pitch sound using neat and labelled diagram. **[2011 (T-II)]**

11. (a) Which wave property determines

(1) loudness (2) pitch?

(b) How are wavelength and frequency related to speed of sound waves? **[2011 (T-II)]**

12. Define the following :

(a) Transverse waves

(b) Time period **[2011 (T-II)]**

13. Sound of explosions taking place on other planets is not heard by a person on the earth. Give reason. **[2011 (T-II)]**

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

[2011 (T-II)]

15. Give two applications of ultrasound.

[2011 (T-II)]

16. Represent graphically two sound waves having same amplitude but different frequencies.

[2011 (T-II)]

17. When the wire of a guitar is plucked, what types of waves are produced in (i) air and (ii) wire? Give reasons in support of your answer.

[2011 (T-II)]

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

(a) frequency of vibration in hertz.

(b) wavelength of the wave produced.

[2011 (T-II)]

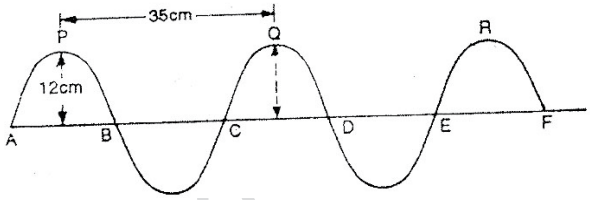
19. Waves of frequency 200 Hz are produced in a string as shown in figure

Find:

(a) amplitude of the wave

(b) wavelength of the wave

(c) velocity of the wave **[2011 (T-II)]**



20. Draw a graph showing a person with soft and loud voice. **[2011 (T-II)]**

21. (a) Sound is produced when your school bell is struck with a hammer. Why?

(b) Which characteristic of sound helps to identify your friend by his voice while sitting with others in a dark room? **[2011 (T-II)]**

22. (a) Write factor on which pitch of a sound depends?

(b) Draw a diagram to represent sound of

(a) high pitch and

(b) low pitch, of the same loudness.

[2011 (T-II)]

23. (a) Which wave property determines?

(i) loudness (ii) pitch

(b) Why are the ceilings of concert halls curved? **[2011 (T-II)]**

24. Give one difference between transverse and longitudinal wave. Give one example for each. **[2011 (T-II)]**

25. What is an echo? Give minimum distance required to hear an echo. Give one application where principle of echo is utilised.

[2011 (T-II)]

26. (a) What type of wave is represented by density - distance graph?

(b) What is meant by transverse wave? Give an example. **[2011 (T-II)]**

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OTHER IMPORTANT QUESTIONS

1. What is transferred by a wave motion, matter or energy? Support your answer by an example.
2. Derive a relation between wave velocity (v), wavelength (λ) and frequency (f).
3. Draw a diagram representing longitudinal wave.
4. What kind of wave is produced when sound energy propagates through air? Give two examples of longitudinal waves.
5. What do you understand by the terms (i) compression (ii) rarefaction, as applied to longitudinal waves.
6. A longitudinal wave is produced in a slinky, such that the frequency of the wave is 20 Hz and the speed of the wave is 30 cms^{-1}. What is the minimum distance of separation between the consecutive compressions of the slinky?
7. Wavelength of ripples produced on the surface of water is 0.14 m. If the velocity of ripples is 42 ms^{-1}, calculate the number of ripples produced in one second.
8. A boat at anchor is rocked by waves, such that distance between two consecutive crests is 100 m. If the wave velocity of the moving crests is 20 ms^{-1}, calculate the frequency of rocking of the boat.
9. A plastic ruler is held near the rotating wheel of a bicycle, such that it produces sound every time the spoke of the wheel strikes it. If 20 clicks are produced in 0.4s, calculate the frequency of sound produced.
10. A bat can hear sound at frequencies up to 120 kHz. Determine the wavelength of sound in air at this frequency. Take the speed of sound in air as 344 ms^{-1}.

III. SHORT ANSWER QUESTIONS - II (3 Marks)

PREVIOUS YEARS' QUESTIONS

1. (a) Why the stage of an auditorium has curved background, curtains, carpets and false ceiling? **[2011 (T-II)]**

   (b) The sound of a ringing bell inside a vacuum chamber cannot be heard. Why?
2. Ocean waves of time period 0.01s have a speed of 15 m/s. Calculate the wavelength of these waves. Find the distance between the adjacent crest and the trough. **[2011 (T-II)]**
3. (a) How the bats make use of ultrasonic waves to catch their prey? Explain? 3

   (b) A radar signal is reflected by an aeroplane and is received 2×10^{-5} s after it was sent. If the speed of these waves is 3×10^{8} ms^{-1}, how far is the aeroplane? **[2011 (T-II)]**
4. (a) Even if a loud explosion were to take place at any place on the moon, it would not be heard at a near by point. Give reason.

   (b) Explain in brief the dependence of speed of sound on nature of material medium and temperature.

   (c) Identify the two factors on which the loudness of sound depends. **[2011 (T-II)]**
5. (a) What causes reverberation of thunder sound ?

   (b) A Sonar device on a submarine sends a signal and receives an echo 5 s later. Calculate the speed of sound in water if the distance of the object from the submarine is 3625 m. **[2011 (T-II)]**
6. Explain how defects in a metal block can be detected using ultrasound. **[2011 (T-II)]**
7. Explain how human ear works in the transmission of sound wave to the brain. **[2011 (T-II)]**
8. Define frequency, amplitude and speed of a sound wave. **[2011 (T-II)]**
9. What is 'Ultrasound'? Explain how defects in a metal block can be detected using ultrasound. **[2011 (T-II)]**
10. State the relationship between frequency and time period of a wave. The wavelength of vibrations produced on the surface of water is 2 cm. If the wave velocity is 16 m/s find its frequency and time period. **[2011 (T-II)]**
11. Define echo. Establish a mathematical relation between speed of sound, distance of reflecting body from source of sound and time for echo. **[2011 (T-II)]**
12. Distinguish between the following : **[2011 (T-II)]**

    (a) Mechanical Waves and Electromagnetic Waves

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(b) Loudness and Intensity

(c) Crest and Compression **[2011 (T-II)]**

13. (a) Does the sound of a bomb explosion travel faster than the sound of the humming bee?

(b) A sonar device on a submarine sends out a signal and receives an echo 5 s later. Calculate the speed of sound. **[2011 (T-II)]**

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

(b) Calculate the wavelength of a sound wave whose frequency is 220 Hz and speed is 440 m/s in a given medium. **[2011 (T-II)]**

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

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

[2011 (T-II)]

16. (a) Which wave property determines?

(i) loudness (ii) pitch

(b) Flash and thunder are produced simultaneously, but thunder is heard few seconds after the flash is seen, why? **[2011 (T-II)]**

17. (a) Mention two practical applications of reflection of sound waves.

(b) A sound wave travels at a speed of 339 m/s. If its wavelength is 1.5 cm, calculate the frequency of the wave. **[2011 (T-II)]**

18. What does acronym sonar stand for? What type of wave does it use? Write any two uses of sonar. **[2011 (T-II)]**

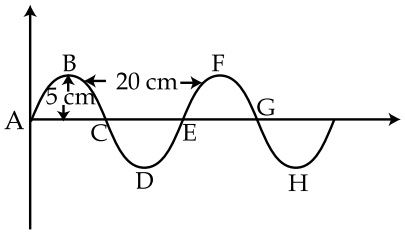
19. A sound wave has a frequency of 5000 Hz and wavelength of 20 cm. How long will it take to travel 1 km? **[2011 (T-II)]**

20. What is an echo? Why do we not get echo in small room? **[2011 (T-II)]**

21. Waves of frequency 100 HZ are produced in a string as shown in Fig: Give it's :

(a) amplitude (b) wavelength

(c) velocity **[2011 (T-II)]**



22. (a) The frequency of a source of sound is 200 Hertz. Calculate the no. of times the source of sound vibrates in 1 minute. Also calculate the time period.

(b) Which wave property determines.

(i) loudness (ii) pitch? **[2011 (T-II)]**

23. (a) What is the range of frequencies associated with **[2011 (T-II)]**

(i) Infrasound (ii) Ultrasound?

(b) Describe an activity to show that sound waves need medium to travel. **[2011 (T-II)]**

24. Describe multiple echoes. Write any two of their important applications. **[2011 (T-II)]**

25. Write any three differences between transverse and longitudinal wave. **[2011 (T-II)]**

26. A boy dropped a stone in a well 45 m deep. If the speed of sound is 340 m/s, then after how much time, he will hear the splash? Take g = 10m/s^2. **[2011 (T-II)]**

27. (a) A boy strikes one end of a long pipe with a stone. Another boy who keeps his ear close to the other end of pipe heard two sounds in a short interval of time. Explain, why?

(b) List two uses of ultrasonics. **[2011 (T-II)]**

28. (a) Illustrate the use of stethoscope.

(b) What are infrasonic and ultrasonic sound waves? **[2011 (T-II)]**

29. Explain the working of human ear.

[2011 (T-II)]

30. (a) Why do we hear sound produced by the humming bees while the sound of vibrations of pendulum is not heard?

(b) Give any two applications of ultrasound.

[2011 (T-II)]

31. (a) Why we cannot hear an echo in a small room?

(b) A wave pulse on a string moves a distance of 8m in 0.05s.

(i) Find the velocity of the pulse.

(ii) What would be the wavelength of the wave on the string if its frequency is 200 Hz? **[2011 (T-II)]**

32. (a) Write the relationship between frequency, wavelength and wave velocity.

(b) The frequency of a tuning fork is 550 Hz. Calculate the wavelength of waves produced by it. (Velocity of sound in air = 332 m/s)

[2011 (T-II)]

33. What are ultrasonic waves? Is human ear able to hear ultrasonic sound? Name the animals which

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are able to hear ultrasonic waves.

[2011 (T-II)]

34. (a) Name the type of waves that can travel in gases.

(b) Name the wave which can travel in solids, liquids as well as gas.

(c) At any instant a compression is formed at a point. After how much time period will be formed at the same point?

(i) a rarefaction (ii) a compression

[2011 (T-II)]

35. Hari and Shivam were playing on identical guitars whose strings were adjusted to give notes of the same pitch. Which of the two, the quality of the two notes and frequencies be the same. Give reason for your answer. **[2011 (T-II)]**

36. The stem of a tuning fork is pressed against a table top. Answer the following questions :

(a) Would the above action produce any audible sound?

(b) Does the above action cause the table to set into vibrations?

(c) If the answer above is yes, what type of vibrations are they?

(d) Under what condition will the above action lead to resonance? **[2011 (T-II)]**

37. A sound wave travels at a speed of 339 m/s ' if the wavelength is 1.2 cm, what is the frequency of the wave. **[2011 (T-II)]**

38. (a) Why are ceilings of concert halls curved?

(b) A person has a hearing range of 20 Hz to 20 kHz. What are the wavelengths of sound waves in air corresponding to these frequencies? **[2011 (T-II)]**

(speed of sound wave in air = 344 ms^{-1})

39. A sound wave has a frequency 2 kHz and wavelength 40 cm. Calculate time it take to travel 1.6 km. **[2011 (T-II)]**

40. (a) Differentiate between transverse and longitudinal waves.

(b) Represent graphically by two separate diagram in each case.

(i) Two sound waves having the same frequency but different amplitudes.

(ii) Two sound waves having different amplitude and also different wavelength.

[2011 (T-II)]

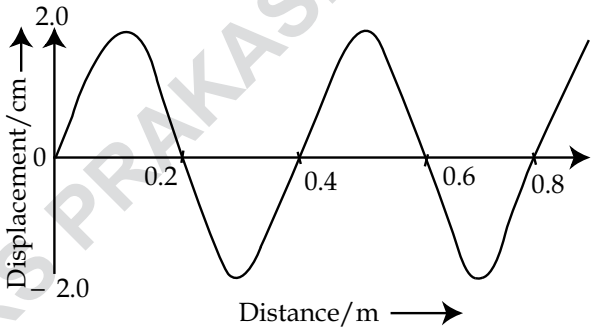
41. Write three medicinal applications of ultrasound **[2011 (T-II)]**

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

(a) Wavelength

(b) Frequency

(c) Amplitude **[2011 (T-II)]**



43. (a) Represent graphically by two separate diagrams two sound waves having the same amplitude but different frequencies.

(b) Which wave property determines?

(i) loudness (ii) pitch **[2011 (T-II)]**

44. A source is producing 1500 sounds waves in 3 seconds. If the distance covered by a compression and an adjacent rarefaction be 68 cm, find

(a) frequency (b) wavelength and

(c) velocity of sound wave. **[2011 (T-II)]**

45. (a) A mobile ringing inside a vacuum chamber cannot be heard outside. Why?

(b) Represent transverse wave graphically.

(c) What is meant by loudness of sound? On what factor does it depend? **[2011 (T-II)]**

OTHER IMPORTANT QUESTIONS

1. 50 sound waves pass through a point in 0.1s. If the distance between one compression and the subsequent rarefaction is 0.34 m, calculate (a)frequency (b) wavelength (c) wave velocity of the longitudinal wave in air.

2. (i) An object is vibrating 61440 times a minute. If the velocity of sound in air is 330 m/s, calculate (a) the frequency of sound in Hertz (b) the wavelength.

(ii) Define amplitude of sound wave.

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3. (i) A radio station is broadcasting at 200 MHz. If the velocity of radio waves is 3×10^8 ms^{-1}, calculate the wavelength of radio waves. [1 MHz = 10^6 Hz]

(ii) Derive a mathematical relationship between time period and frequency.

(iii) What do you mean by timbre with respect to a sound wave?

4. (i) A thin metal plate is placed against the teeth of a cog wheel. The cog wheel is rotated at a speed of 120 rotations per minute and has 160 teeth. Calculate the (a) frequency of the note produced (b) speed of sound, if the wavelength is 1.05 m.

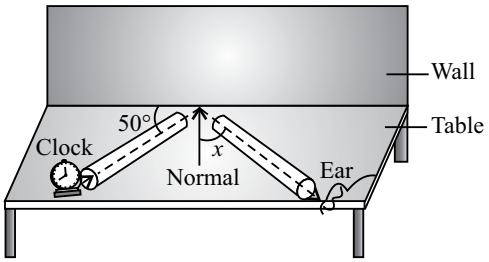
(ii) Derive a relation between wave velocity (v), wavelength (λ) and time period (t).

5. A girl is sitting in the middle of a park of dimension 12 m × 12 m. 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? Explain your answer.

6. (i) If any explosion takes place at the bottom of a lake, what type of shock waves will take place in water?

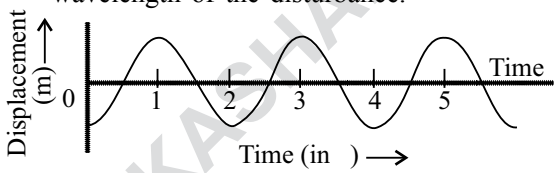
(ii) Sound produced by a thunderstorm is heard 10 s after the lightning is seen. Calculate the approximate distance of the thunder cloud. (Given speed of sound = 340 ms^{-1}.)

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

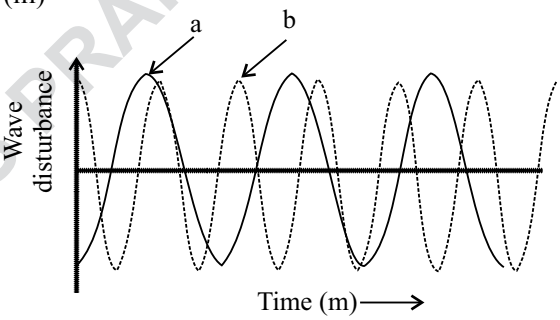


7. (i) Why is the ceiling made dome shaped and the wall behind the stage of good conference halls or concert halls made curved?

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



(iii)



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

IV. LONG ANSWER QUESTIONS (5 Marks)

PREVIOUS YEARS' QUESTIONS

1. (a) How do our ears permit us to receive the sound?

(b) Explain the structure and working of human ear with labelled diagram. **[2011 (T-II)]**

2. (a) Write the full name of sonar. How will you determine the depth of a sea using echo ranging?

(b) A sonar device on a submarine sends out a signal and receives an echo 5 s later. Calculate the speed of sound in water if the distance of the object from the submarine is 3625 m. **[2011 (T-II)]**

3. (a) If velocity of sound in air is 340 m/s. Calculate

(i) wavelength when frequency is 256 Hz.

(ii) frequency when wavelength is 0.85 m.

(b) What is meant by reflection of sound? State the laws of reflection of sound. **[2011 (T-II)]**

4. (a) What is meant by echo?

(b) State two conditions for hearing a distinct echo.

(c) A ship sends out ultrasound that returns from the sea bed and is detected after 3.4 s. If the speed of sound in sea water is 1500 m/s, calculate the distance of sea bed from the ship? **[2011 (T-II)]**

5. (a) Mention two practical applications of reflection of sound waves.

(b) How is the pressure variation in a sound wave amplified in human ear?

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(c) In a ripple tank, ten ripples are produced per second. If the distance between a trough and a neighbouring crest is 12 cm, calculate the frequency, wavelength and velocity of the wave. **[2011 (T-II)]**

6. (a) What is meant by intensity of sound?

(b) Mention the conditions for an echo to be heard clearly.

(c) A ball is dropped into a pond from a height of 44.1 m. The splash of sound is heard 3.13 second after the ball is dropped. Determine the velocity of sound in air. **[2011 (T-II)]**

OTHER IMPORTANT QUESTIONS

1. (i) 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.

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

2. (i) What is the unit of frequency?

(ii) What is a compression and rarefaction?

(iii) What is the time period of a sound wave of frequency 2000 Hz?

(iv) By giving an example, explain what do you understand by the term pulse?

3. (i) How does a sonar detect the depth of submerged objects?

(ii) State two differences between infrasound waves and ultrasound waves.

(iii) Which property determines pitch of sound?

4. (i) Define an echo. State two uses of echoes.

(ii) The velocity of sound in medium A and B is 540 ms^{-1} and 350 ms^{-1}. Calculate the ratio of time in which sound travels through them for the same length.

5. (i) Define reverberation.

(ii) How can reverberation produced in an enclosed space be reduced?

(iii) State the laws of reflection of sound waves.

ASSIGNMENTS FOR FORMATIVE ASSESSMENT

A. Demonstration

Teachers are requested to demonstrate the experiment ''sound needs a material medium for propagation'' provided they have the necessary equipments in their laboratory.

B. Activity

To find which of the following materials produce more sound than others. Take a steel spoon and strike it gently on (i) coffee table, (ii) a dinning table, (iii) a plastic suitcase (iv) a pillow (v) a sofa, etc. Strike the spoon on at least 40 items around you. Make a note of the objects, which produce (a) no sound (b) feeble sound (c) loud sound (d) sharp sound.

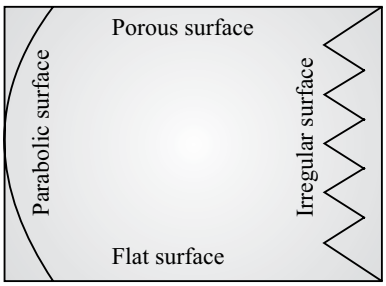
C. Seminar

Request the school doctor to explain how ultrasonic waves are used in (i) detection of abnormalities in the body (ii) curing certain diseases with operation.

D. Discussions

(A) Discuss at least six or more situations where ultrasound waves are used by us or the animals. Make an exhaustive chart of the use of ultrasonic waves.

(B) Analyse the following and explain why the wave reacts differently on what surface it hits :



1. What happens when a sound wave hits a flat surface?

2. What happens when a sound wave hits a porous surface?

3. What happens when a sound wave hits an irregular surface?

4. What happens when a sound wave hits a concave shaped surface?

5. What will happen if the irregular surface is replaced by another parabolic surface? Justify.

E. Charts

Make a coloured chart of the human ear.

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Class IX Chapter 12 – Sound Science

Question 1:

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

Answer:

When an object vibrates, it forces the neighbouring particles of the medium to vibrate. These vibrating particles then force the particles adjacent to them to vibrate. In this way, vibrations produced by an object are transferred from one particle to another till it reaches the ear.

Explain how sound is produced by your school bell.

Answer:

When the school bell vibrates, it forces the adjacent particles in air to vibrate. This disturbance gives rise to a wave and when the bell moves forward, it pushes the air in front of it. This creates a region of high pressures known as compression. When the bell moves backwards, it creates a region of low pressure know as rarefaction. As the bell continues to move forward and backward, it produces a series of compressions and rarefactions. This makes the sound of a bell propagate through air.

Question 2:

Why are sound waves called mechanical waves?

Answer:

Sound waves force the medium particles to vibrate. Hence, these waves are known as mechanical waves. Sound waves propagate through a medium because of the interaction of the particles present in that medium.

Question 3:

Suppose you and your friend are on the moon. Will you be able to hear any sound produced by your friend?

Answer:

Sound needs a medium to propagate. Since the moon is devoid of any atmosphere, you cannot hear any sound on the moon.

Which wave property determines (a) loudness, (b) pitch?

Answer:

(a) Amplitude (b) Frequency

(a) The loudness of a sound depends on its amplitude. If the amplitude of a sound is large, then the sound produced will also be loud.

(b) The pitch of a sound depends on its frequency. A sound will be considered a high pitched sound, if its frequency is high.

Question 2:

Guess which sound has a higher pitch: guitar or car horn?

Answer:

The frequency of the vibration of a sound produced by a guitar is greater than that produced by a car horn. Since the pitch of a sound is proportional to its frequency, the guitar has a higher pitch than a car horn.

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

Answer:

Wavelength: The distance between two consecutive compressions or two consecutive rarefactions is known as the wavelength. Its SI unit is metre (m).

Frequency: The number of complete oscillations per second is known as the frequency of a sound wave. It is measured in hertz (Hz).

Amplitude: The maximum height reached by the crest or trough of a sound wave is

called its amplitude.

Question 2:

How are the wavelength and frequency of a sound wave related to its speed?

Answer:

Speed, wavelength, and frequency of a sound wave are related by the following equation:

v

$v = \lambda \times \upsilon$) = Wavelength ($\lambda$) × Frequency ($\upsilon$)

Question 3:

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

Answer:

Frequency of the sound wave, υ = 220 Hz

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

For a sound wave,

Speed = Wavelength × Frequency

$$v = \lambda \times \upsilon$$

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

Hence, the wavelength of the sound wave is 2 m.

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Question 4:

A person is listening to a tone of 500 Hz sitting at a distance of 450 m from the source of the sound. What is the time interval between successive compressions from the source?

Answer:

The time interval between two successive compressions is equal to the time period of the wave. This time period is reciprocal of the frequency of the wave and is given by

the relation:

$$T = \frac{1}{\text{Frequency}} = \frac{1}{500} = 0.002 \text{ s}$$

Distinguish between loudness and intensity of sound.

Answer:

Intensity of a sound wave is defined as the amount of sound energy passing through a unit area per second. Loudness is a measure of the response of the ear to the sound. The loudness of a sound is defined by its amplitude. The amplitude of a sound decides its intensity, which in turn is perceived by the ear as loudness.

In which of the three media, air, water or iron, does sound travel the fastest at a particular temperature?

Answer:

The speed of sound depends on the nature of the medium. Sound travels the fastest in solids. Its speed decreases in liquids and it is the slowest in gases.

Therefore, for a given temperature, sound travels fastest in iron.

An echo returned in 3 s. What is the distance of the reflecting surface from the source, given that the speed of sound is 342 m s^{-1}?

Answer:

Speed of sound, v = 342 m s^{-1}

Echo returns in time, t = 3 s

Distance travelled by sound = v × t = 342 × 3 = 1026 m

In the given time interval, sound has to travel a distance that is twice the distance of the reflecting surface and the source.

Hence, the distance of the reflecting surface from the source $= \frac{1026}{2}\ \text{m} = 513\ \text{m}$

Why are the ceilings of concert halls curved?

Answer:

Ceilings of concert halls are curved so that sound after reflection (from the walls) spreads uniformly in all directions.

What is the audible range of the average human ear?

Answer:

The audible range of an average human ear lies between 20 Hz to 20,000 Hz. Humans cannot hear sounds having frequency less than 20 Hz and greater than 20,000 Hz.

Question 2:

What is the range of frequencies associated with (a) Infrasound? (b) Ultrasound?

Answer:

(a) Infrasound has frequencies less than 20 Hz.

(b) Ultrasound has frequencies more than 20,000 Hz.

A submarine emits a sonar pulse, which returns from an underwater cliff in 1.02 s. If the speed of sound in salt water is 1531 m/s, how far away is the cliff?

Answer:

Time taken by the sonar pulse to return, t = 1.02 s

Speed of sound in salt water, v = 1531 m s^{-1}

Distance of the cliff from the submarine = Speed of sound × Time taken

Distance of the cliff from the submarine $= 1.02 \times 1531 = 1561.62 \text{ m}$

Distance travelled by the sonar pulse during its transmission and reception in water = 2 × Actual distance = 2d

$$\text{Actual distance, } d = \frac{\text{Distance of the cliff from the submarine}}{2}$$

$$= \frac{1561.62}{2} = 780.31 \text{ m}$$

What is sound and how is it produced?

Answer:

Sound is produced by vibration. When a body vibrates, it forces the neighbouring particles of the medium to vibrate. This creates a disturbance in the medium, which travels in the form of waves. This disturbance, when reaches the ear, produces sound.

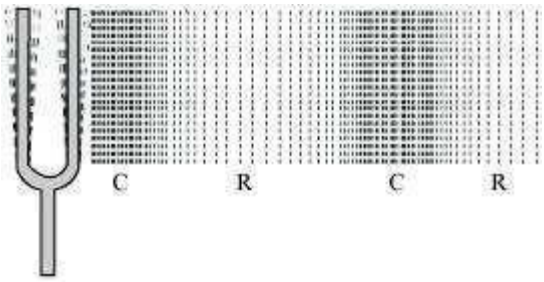
Question 2:

Describe with the help of a diagram, how compressions and rarefactions are produced in air near a source of sound.

Answer:

When a vibrating body moves forward, it creates a region of high pressure in its vicinity. This region of high pressure is known as compressions. When it moves backward, it creates a region of low pressure in its vicinity. This region is known as a rarefaction.

As the body continues to move forward and backwards, it produces a series of compressions and rarefactions (as shown in the following figure).

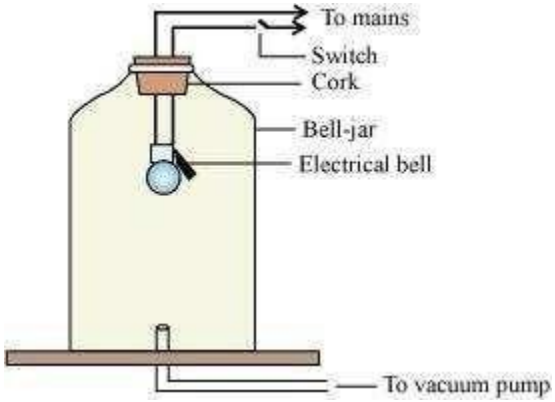


Question 3:

Cite an experiment to show that sound needs a material medium for its propagation.

Answer:

Take an electric bell and hang this bell inside an empty bell-jar fitted with a vacuum pump (as shown in the following figure).



Initially, one can hear the sound of the ringing bell. Now, pump out some air from the bell-jar using the vacuum pump. It will be observed that the sound of the ringing bell decreases. If one keeps on pumping the air out of the bell-jar, then at one point, the glass-jar will be devoid of any air. At this moment, no sound can be heard from the ringing bell although one can see that the prong of the bell is still vibrating. When there is no air present inside, we can say that a vacuum is produced. Sound cannot travel through vacuum. This shows that sound needs a material medium for its propagation.

Question 4:

Why is sound wave called a longitudinal wave?

Answer:

The vibration of the medium that travels along or parallel to the direction of the wave is called a longitudinal wave. In a sound wave, the particles of the medium vibrate in the direction parallel to the direction of the propagation of disturbance.

Hence, a sound wave is called a longitudinal wave.

Question 5:

Which characteristics of the sound helps you to identify your friend by his voice while sitting with others in a dark room?

Answer:

Quality of sound is that characteristic which helps us identify a particular person. Sound produced by two persons may have the same pitch and loudness, but the quality of the two sounds will be different.

Question 6:

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

Answer:

The speed of sound $(344\ \text{m/s})$ is less than the speed of light $(3\times10^{8}\ \text{m/s})$. Sound of thunder takes more time to reach the Earth as compared to light. Hence, a flash is seen before we hear a thunder.

Question 7:

A person has a hearing range from 20 Hz to 20 kHz. What are the typical wavelengths of sound waves in air corresponding to these two frequencies? Take the speed of sound in air as 344 m s^{-1}.

Answer:

For a sound wave,

Speed = Wavelength × Frequency

$v = \lambda \times \upsilon$

Given that the speed of sound in air = 344 m/s

(i) For, υ = 20 Hz

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

(ii) For, $\upsilon_2 = 20,000\ \text{Hz}$

$$\lambda_2 = \frac{v}{\upsilon_2} = \frac{344}{20,000} = 0.0172\ \text{m}$$

Hence, for humans, the wavelength range for hearing is 0.0172 m to 17.2 m.

Question 8:

Two children are at opposite ends of an aluminium rod. One strikes the end of the rod with a stone. Find the ratio of times taken by the sound wave in air and in aluminium to reach the second child.

Answer:

Let the length of the aluminium rod be d.

Speed of sound wave in aluminium at 25°C, $v_{Al} = 6420\ \text{m s}^{-1}$

Therefore, time taken by the sound wave to reach the other end,

$$t_{Al} = \frac{d}{v_{Al}} = \frac{d}{6420}$$

Speed of sound wave in air at 25°C, $v_{Air} = 346\ \text{m s}^{-1}$

Therefore, time taken by sound wave to reach the other end,

$$t_{Air} = \frac{d}{v_{Air}} = \frac{d}{346}$$

The ratio of time taken by the sound wave in air and aluminium:

$$\frac{t_{Air}}{t_{Al}} = \frac{\frac{d}{346}}{\frac{d}{6420}} = \frac{6420}{346} = 18.55$$

Question 9:

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

Answer:

Frequency is defined as the number of oscillations per second. It is given by the relation:

$$\text{Frequency} = \frac{\text{Number of oscillations}}{\text{Total time}}$$

Number of oscillations = Frequency × Total time

Given, Frequency of sound = 100 Hz

Total time = 1 min = 60 s

Number of oscillations/Vibrations = 100 × 60 = 6000

Hence, the source vibrates 6000 times in a minute, producing a frequency of 100 Hz.

Question 10:

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

Answer:

Sound follows the same laws of reflection as light does. The incident sound wave and the reflected sound wave make the same angle with the normal to the surface at the point of incidence. Also, the incident sound wave, the reflected sound wave, and the normal to the point of incidence all lie in the same plane.

Question 11:

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?

Answer:

An echo is heard when the time interval between the original sound and the reflected sound is at least 0.1 s. The speed of sound in a medium increases with an increase in temperature. Hence, on a hotter day, the time interval between the original sound and the reflected sound will decrease. Therefore, an echo can be heard only if the time interval between the original sound and the reflected sound is greater than 0.1 s.

Question 12:

Give two practical applications of reflection of sound waves.

(i) Reflection of sound is used to measure the distance and speed of underwater objects. This method is known as SONAR.

(ii) Working of a stethoscope is also based on reflection of sound. In a stethoscope, the sound of the patient's heartbeat reaches the doctor's ear by multiple reflection of sound.

Question 13:

A stone is dropped from the top of a tower 500 m high into a pond of water at the base of the tower. When is the splash heard at the top? Given, g = 10 m s^{-2} and speed of sound = 340 m s^{-1}.

Answer:

Height of the tower, s = 500 m

Velocity of sound, v = 340 m s^{-1}

Acceleration due to gravity, g = 10 m s^{-2}

Initial velocity of the stone, u = 0 (since the stone is initially at rest)

Time taken by the stone to fall to the base of the tower, t_1

Answer:

According to the second equation of motion:

$$s = ut_1 + \frac{1}{2}gt_1^2$$

$$500 = 0 \times t_1 + \frac{1}{2} \times 10 \times t_1^2$$

$$t_1^2 = 100$$

$$t_1 = 10 \text{ s}$$

$$t_2 = \frac{500}{340} = 1.47 \text{ s}$$

Therefore, the splash is heard at the top after time, t

$$t = t_1 + t_2 = 10 + 1.47 = 11.47 \text{ s}$$

Where,

Question 14: Now, time taken by the sound to reach the top from the base of the tower,

A sound wave travels at a speed of 339 m s^{-1}. If its wavelength is 1.5 cm, what is the frequency of the wave? Will it be audible?

Answer:

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

Wavelength of sound, λ = 1.5 cm = 0.015 m

Speed of sound = Wavelength × Frequency

$$v = \lambda \times \upsilon$$

$$\therefore \upsilon = \frac{v}{\lambda} = \frac{339}{0.015} = 22600 \text{ Hz}$$

The frequency range of audible sound for humans lies between 20 Hz to 20,000 Hz.

Since the frequency of the given sound is more than 20,000 Hz, it is not audible.

Question 15:

Answer:

What is reverberation? How can it be reduced?
Persistence of sound (after the source stops producing sound) due to repeated

reflection is known as reverberation. As the source produces sound, it starts travelling in all directions. Once it reaches the wall of a room, it is partly reflected back from the wall. This reflected sound reaches the other wall and again gets reflected partly. Due to this, sound can be heard even after the source has ceased to produce sound.

To reduce reverberations, sound must be absorbed as it reaches the walls and the ceiling of a room. Sound absorbing materials like fibreboard, rough plastic, heavy curtains, and cushioned seats can be used to reduce reverberation.

Question 16:

What is loudness of sound? What factors does it depend on?

Answer:

A loud sound has high energy. Loudness depends on the amplitude of vibrations. In fact, loudness is proportional to the square of the amplitude of vibrations.

Question 17:

Explain how bats use ultrasound to catch a prey.

Answer:

Bats produce high-pitched ultrasonic squeaks. These high-pitched squeaks are

reflected by objects such as preys and returned to the bat’s ear. This allows a bat to know the distance of his prey.

Question 18:

How is ultrasound used for cleaning?

Answer:

Objects to be cleansed are put in a cleaning solution and ultrasonic sound waves are passed through that solution. The high frequency of these ultrasound waves detaches the dirt from the objects.

Question 19:

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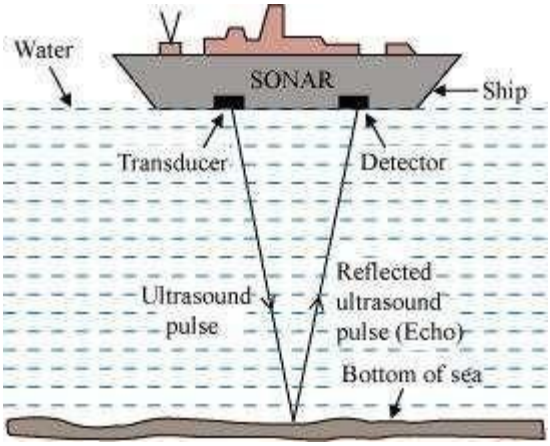
Explain the working and application of a sonar.

Answer:

SONAR is an acronym for Sound Navigation And Ranging. It is an acoustic device used to measure the depth, direction, and speed of under-water objects such as submarines and ship wrecks with the help of ultrasounds. It is also used to measure the depth of

seas and oceans.



A beam of ultrasonic sound is produced and transmitted by the transducer (it is a device that produces ultrasonic sound) of the SONAR, which travels through sea water. The echo produced by the reflection of this ultrasonic sound is detected and recorded by the detector, which is converted into electrical signals. The distance (d) of the underwater object is calculated from the time (t) taken by the echo to return with speed (v) is given by $2d = v \times t$. This method of measuring distance is also known as 'echo-

ranging'.

Question 20:

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

Answer:

Time taken to hear the echo, t = 5 s

Distance of the object from the submarine, d = 3625 m

Total distance travelled by the sonar waves during the transmission and reception in water = 2d

Velocity of sound in water, $v = \frac{2d}{t} = \frac{2 \times 3625}{5} = 1450 \text{ m s}^{-1}$

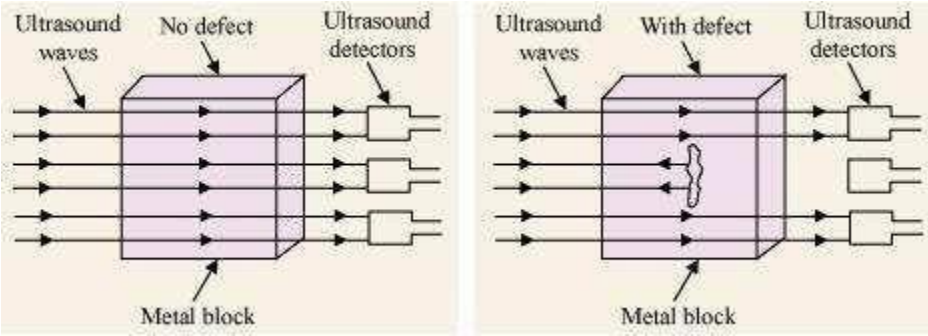
Question 21:

Explain how defects in a metal block can be detected using ultrasound.

Answer:

Defects in metal blocks do not allow ultrasound to pass through them and they are reflected back. This fact is used to detect defects in metal blocks. Ultrasound is passed through one end of a metal block and detectors are placed on the other end. The defective part of the metal block does not allow ultrasound to pass through it. As a result, it will not be detected by the detector. Hence, defects in metal blocks can be

detected using ultrasound.



Question 22:

Explain how the human ear works.

Answer:

Different sounds produced in our surroundings are collected by pinna that sends these sounds to the ear drum via the ear canal. The ear drum starts vibrating back and forth rapidly when the sound waves fall on it. The vibrating eardrum sets the small bone

hammer into vibration. The vibrations are passed from the hammer to the second bone anvil, and finally to the third bone stirrup. The vibrating stirrup strikes on the membrane of the oval window and passes its vibration to the liquid in the cochlea. This produces electrical impulses in nerve cells. The auditory nerve carries these electrical impulses to the brain. These electrical impulses are interpreted by the brain as sound

and we get a sensation of hearing.