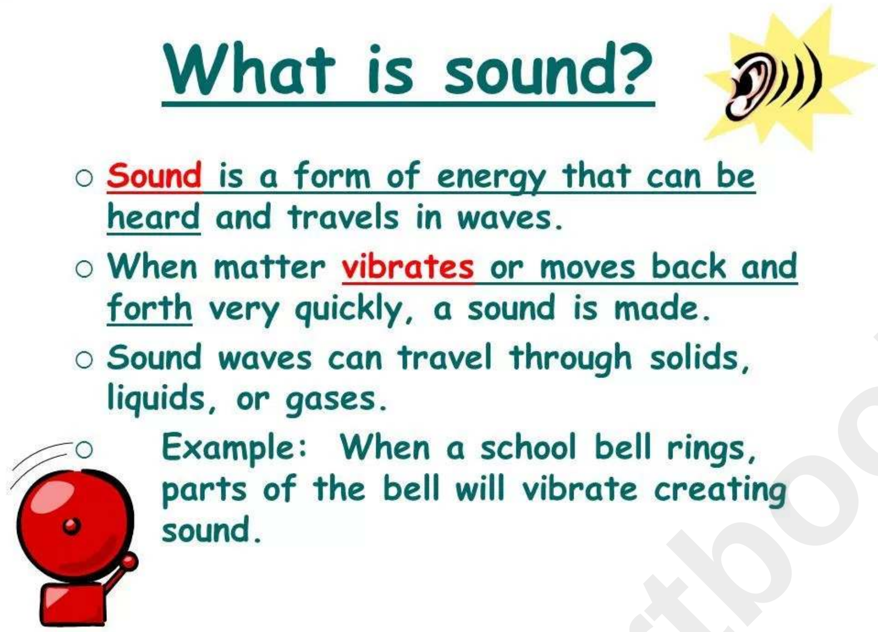
Chapter 6. Echoes and Vibrations of Sound

Short Answers

Question 1: What is a sound? What causes it to produce?

Answer: Sound is a form of energy. It is that external physical cause which affects the ear to produce the sensation. Sound is produced only when some material body is made to vibrate.



Question 2: Define the term Amplitude.

Answer: The maximum displacement from mean position in vibration of a wave is called amplitude.

Question 3: Define the term Frequency (as applied to sound waves)

Answer: The number of vibrations per second taken by a wave is called its frequency.

Question 4: What are mechanical waves?

Answer: Mechanical waves are waves which needs material medium for its propagation i.e., cannot travel in vacuum, e.g. sound waves

Question 5: Name the unit used for measuring the sound level.

Answer: Unit for measuring sound level—Decibel.

Question 6: Name the subjective property of sound related to its frequency.

Answer: The subjective property of sound related to its frequency is pitch.

Question 7: Name the subjective property of light related to its wavelength.

Answer: The subjective property of light related to its wavelength is colour.

Question 8: State two differences between light waves and sound waves.

Answer: Two differences between light waves and sound waves.

Light waves	Sound waves
1. Light waves do not require a medium for propagation.	Sound waves require a medium for propagation.
2. Light waves travel with a speed of 3×10^8 m/s.	Sound waves travel with a speed of 332 m/s.

Question 9: How does frequency affect a musical sound?

Answer: In musical sound the component wave do not change their wavelength hence the frequency and amplitude affect a musical sound like this.

Question 10: Can sound waves travel in vacuum?

Answer: No, sound waves cannot travel in vacuum because there are no material particles which can vibrate and propagate energy.

Question 11: How is sound perceived by us?

Answer: Sound requires material medium for its propagation. It is produced when a body vibrates. The vibrations produced at a point are transmitted in the medium (air) from one point to the next and so on in the form of mechanical waves which produce compressions and rarefactions in air. These compressions and rarefactions produce vibrations in the ear drum which are perceived by us as sound.

Question 12: Define sound ranging. Give one use of sound ranging.

Answer: The process by which bats and dolphins detect the presence of an obstacle by hearing the echo of the sound produced by them is called sound ranging. These are used in RADAR.

Question 13: What are ultrasonic and infrasonic waves?

Answer: The waves of frequency above 20,000 Hz are called ultrasonic waves. The waves of frequency below 20 Hz are called infrasonic waves.

Question 14: Arrange the speeds of sound in gases, solids and liquids in an ascending order.

Answer: The speed of sound is lowest in gases, higher in liquid and highest in soilds.

Question 15: Point out the waves from the given list, i.e., light, sound, radio waves, ultrasonic waves and thermal radiation, the energy is propagated by mechanical waves.

Answer: The energy, in sound and ultrasonic waves, is propagated by mechanical waves.

Question 16: Write the approximate value of speed of sound in (i) air, (ii) water, and (iii) iron.

Answer: (i) The speed of sound in air = 340 ms^{-1} (ii) The speed of sound in water = 1500 ms^{-1} (iii) The speed of sound in iron = 5100 ms^{-1}.

Question 17: Two astronauts cannot hear each other on the moon. Why?

Answer: Material medium is necessary for the propagation of sound. On the mOon there is vacuum, i.e. no air, therefore sound cannot propagate on the moon. Thus the astronauts can not hear each other.

Question 18: Name the factors which determine: (i) the loudness, (ii) pitch, and (iii) the quality of a note.

Answer: (i) The loudness of a note is determined by its amplitude.
(ii) The pitch of a note determined by its frequency.
(iii) The quality of a note is determined by its wave form.
(i.e., the presence of secondary tones along with the principal note)

Question 19: How can one distinguish the sounds of two musical instruments even if they are of same pitch and same loudness?

Answer: The sounds of two musical instruments of the same pitch and same loudness can be distinguished by their wave forms.

Question 20: If the amplitude of a wave is doubled, how is its loudness affected?

Answer: The loudness will become four times.

Question 21: 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?

Answer: If the two strings are plucked at different places in the same way and their lengths be adjusted such as they give notes of the same pitch and loudness, their waveforms will differ. Hence they will be of different quality.

Question 22: The same musical note when played on a piano and when played on a flute sounds different.

Answer: The quality of sound produced by the two instruments is different. The quality of the sound depends upon the resultant wave form which depends upon the number of overtones and their relative intensities.

Question 23: Name the characteristics of a musical sound.

Answer: There are three main characteristics: (i) Intensity or loudness, (ii) Pitch, and (iii) Quality.

Question 24: Name one main factor on which each characteristic such as intensity, pitch and quality of musical sound depends.

Answer: Intensity depends on amplitude, pitch on frequency and quality on waveform.

Question 25: When a gun is fired at a distance, why is it that the flash is seen almost instantaneously while the sound is heard a little later?

Answer: The reason is that the speed of light in air is 3×10^8 ms^{-1} which is much larger as compared to the speed of sound in air 3×10^2 ms^{-1}. Hence light takes almost negligible time in comparison to sound in reaching us from the gun.

Question 26: Mention two properties of a wave: one property which varies and the other which remains constant when the wave passes from one medium to another.

Answer: Here we refer to a mechanical wave, its two properties are:
(i) These waves transmit only energy and momentum through the limited motion of the particles of the medium.
(ii) While transmitting energy, the medium remains unshifted, i.e., only energy is transmitted while particles of the matter of the medium do not travel with the same.

Question 27: Name one property of waves that do not change when the wave passes from one medium to another.

Answer: Property of wave that does not change is frequency.

Question 28: A bucket kept under a running tap is getting filled with water. A person sitting at a distance is able to get an idea when the bucket is about to be filled.
(i) What change takes place in the sound to give this idea?
(ii) What causes the change in the sound?

Answer: (i) As the bucket is filled the sound gradually increases.
(ii) Frequency ∝ 1/length; Resonance takes place.

Question 29: Which characteristics of sound will change if there is a change in its amplitude and its waveform.

Answer: Amplitude changes—Loudness changes.

Question 30: What is the range of audibility?

Answer: The range of audibility is in between 20 Hz to 20,000 Hz.

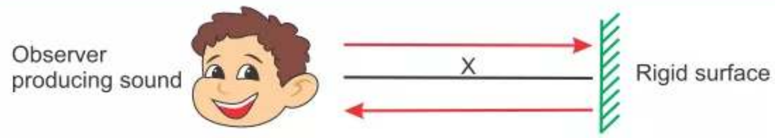
Question 31: What is meant by an echo? What is the condition necessary for an echo to be heard distinctly?

Answer: The sound heard after reflection is known as an echo. To hear the echo distinctly, the obstacle should be at a minimum distance of 17m from the observer.

Echo

The sound heard after reflection is called echo.

It is produced when two distinct sounds are heard due to reflection of sound at an interval of atleast 0.1sec.



To calculate minimum distance required to produce an echo:

Given: Time t = 0.1 sec = Minimum time require to hear echo
Speed of sound in air = 332 m/s at 0 °C
x = Distance between observer and rigid surface
2x = Total distance travelled by the sound from observer to rigid surface and returning to observer again.

$$\text{speed} = \frac{\text{total distance}}{\text{time}}$$

total distance = speed × time
2x = 332X 0.1
x = 16.6 metre

Sometimes echo of the same sound is heard more than once. Such multiple echoes are known as Reverberations.

Minimum distance require to hear an echo = 16.6 metre.

Question 32: What is meant by echo depth sounding?

Answer: The method by which the position of an obstacle hidden in water is located is known as echo depth sounding.

Question 33: Why will an echo not be heard when the distance between the source of sound and the reflecting surface is 10 m?

Answer: Echo will not be heard because minimum distance between the source and the reflecting surface should be 17 m.

Question 34: State two applications of echo.

Answer: Echoes are useful in many ways, such as:

(i) Bats and dolphins, (ii) Fishing Travellers and ships.

Question 35: What is sonar? Give the principle of sonar.

Answer: Sonar is an instrument that makes use of ultrasonic waves for sound ranging. It is equipped to measure even short time intervals quite accurately. A sonar works on the principle of echoes. We use it to send a strong and short (ultrasonic) signal towards the bottom of the ocean. The reflected signal is then detected by it. From the knowledge of the time after which the reflected sound (echo) reaches it, we can calculate the depth of the ocean.
Depth of ocean = $v \times t/2$
Where v is the velocity of wave in water and T is the time after which the echo reaches back to the sonar.

Question 36: How are bats able to fly in the dark?

Answer: Sound waves of frequency higher than 20,000 hertz are not audible to human ears. Those are known as ultrasonics. Let us explain how bats can avoid obstacles while flying in complete darkness. During flight in complete darkness, a bat producess ultrasound in series of impulses. The impulses on reflection from the obstacle under observation are received by the animal. The animal interprets the distance of the obstacle from the time interval between the transmission and reception of the impulses. The phase difference between the echoes received by the ears enables the animal to locate the exact position of the obstacle.

Question 37: What do you understand by 'Echo-location system of Dolphins'?

Answer: It is similar to that of bats. It enables the dolphin to navigate among its companions and larger objects. It also enables the dolphin to detect fish, squid and even small shrimp.

Question 38: What are fishing boats?

Answer: These boats are provided with SONAR which stands for Sound Navigation and Ranging. The sound is the ultrasound which enables boatsmen to exactly pin point the location of fish in deep water. SONAR not only gives the distance but also the exact location of the prey.

Question 39: How does the presence of medium affect the amplitude of free vibrations of a body?

Answer: The presence of medium decreases the amplitude of free vibrations of the body since it exerts a frictional force on the body which has a tendency to resists the motion.

Question 40: State two factors on which natural frequency of a body depends.

Answer: (i) The shape of the body, and (ii) The size of the body.

Question 41: A metallic blade is made to vibrate at its one end by keeping its other end clamped. The vibrations of the blade die away after some time. Explain, how you lower the frequency of the vibration of the blade?

Answer: The vibrations of the blade die away after some time due to air resistance (or damping)
The frequency of vibration of the blade can be lowered:
(i) Increasing the vibrating length of the blade, (ii) Increasing the thickness of blade.

Question 42: What do you understand by the damped vibration? Give one example.

Answer: The periodic vibrations of a body of amplitude decreasing with time, due to the presence of medium, are called damped vibrations.

Example: The vibrations of a simple pendulum in air.
The displacement—time graph showing damped vibration is given in figure.

Question 43: What are forced vibrations? Give two examples.

Answer: When an oscillatory system is made to oscillate under the action of an externally applied periodic force, it is said to execute a 'forced vibration'.
Examples:
(i) The vibrations produced in the board of a guitar when its string is made to vibrate.
(ii) The vibrations produced in the table top when the stem of a vibrating tuning fork is pressed against it.

Question 44: What do you mean by resonance? When does a resonance occur?

Answer: Resonance is a special case of forced vibration, when a body vibrates under the influence of an external periodic force, with a very large amplitude. Resonance occurs when the frequency of external force is either equal to or is integer multiple of the natural frequency of the vibrating body.

Question 45: Explain why does a wine glass start rattling, when a note of some particular frequency is struck by a piano?

Answer: When the glass rattles, at that moment, its natural frequency corresponds with frequency of piano note thus, resonance takes place, which makes the glass to vibrate violently.

Question 46: When acoustic resonance takes place, a loud sound is heard. Why does this happen? Explain.

Answer: When acoustic resonance takes place, a loud sound is heard. This is because the natural frequency becomes equal to the frequency of external applied force hence a loud sound is heard.

Question 47: Explain why stringed musical instruments, like the guitar, are provided with a hollow box.

Answer: Stringed instruments are provided with a hollow box' so that resonance may take place and a loud sound can be produced.

Question 48: State two ways in which resonance differs from forced vibrations.

Answer: (i) In resonance it is necessary that frequency of externally applied force should be equal to natural frequency of the body whereas, it is not necessary for forced vibrations.
(ii) In forced oscillations the amplitude of oscillations is small whereas, in resonance the amplitude of vibration is large.

Question 49: The rear view mirror of a motor bike starts vibrating vibrating violently at some particular speed of the motor bike. What is the name of the phenomenon taking place? Why does the happen?

Answer: This phenomenon is called 'resonance'. In this phenomenon when a body begins with the natural frequency of the others vibrating body B, then A begins to vibrate violently with the maximum amplitude.
The frame of a motor cycle along with the rear view mirror is found to vibrate viotently when it is driven to a particular speed, this happens when the frame has the natural frequency of vibration equal to that of the piston when the engine is driven at that particular, speed.

Question 50: The rear view mirror of a motor bike starts vibrating violently at some particular speed of the motor bike, what could be done to stop the violent vibrations.

Answer: This can be stopped by mounting the engine on such a structure, say steel springs that absorbs the vibrations of the engine without communicating them to the frame and in this condition the rear view mirror attached to the frame will not vibrate vilently.

Question 51: When a troop crosses a suspension bridge, the soliders are asked to break step. Explain.

Answer: The reason is that when soldiers are in steps, they all exert forces in the same phase and so strong vibrations of a particular frequency are produced. If this frequency becomes equal to the natural frequency of the bridge, it will start vibrating with large amplitude due to resonance and it may crumble down.

Question 52: Explain why are soldiers asked to walk out of step while crossing bridges?

Answer: When the soldiers walk in step, they produce some fixed frequency. If this frequency corresponds the natural frequency of bridge, the resonance can take place. This in turn will make the bridge to vibrate violently, and hence make it collapse. To avoid such a situation, the soliders are asked not to march in step.

Question 53: A cork piece is floating on the surface of water in a pond. A piece of pebble is dropped into the water. What will be your observation?

Answer: As the piece of pebble is dropped into the water, waves are seen to be formed on the surface of water which travel outwards from the point, where the pebble strikes the water surface. The cork piece simply tosses up and down without any appreciable forward or backward displacement. From this observation, it is concluded that water (medium) does not move, but the wave (or disturbance) advances.

Question 54: Explain why does rear mirror of a motor bike start Vibrating Violently, at some particular speed of motor bike?

Answer: When the frequency of the engine of motor bike corresponds with the natural frequency of rear view mirror, die resonance takes place. Thus, rear view mirror vibrates with a larger amplitude violently.

Question 55: Explain a tuning fork (vibrating) is held close to ear. One hears a faint sound. The same vibrating tuning fork is placed on table, such that its handle is in contact with table, one hears a loud sound.

Answer: When the tuning fork is held close to ear, then small amount of air is disturbed and hence sound is faint. When the handle of the vibrating tuning fork is held aganist table, it makes the table top to vibrate, with forced vibrations. As the table top has a larger surface area, therefore large volume of air is set into vibrations, thereby producing a loud sound.

Question 56: With which of the following frequencies does a tuning fork of 256 Hz resonate? 288 Hz, 314 Hz, 333 Hz. 512 Hz.

Answer: Tuning fork will resonate with 512 Hz.

Question 57: A vibrating tuning fork is placed over the mouth of a burette filled with water. The tap is opened and the water level gradually falls. It is observed that the sound becomes the loudest for a particular length of air column. What is the name of the phenomenon taking place when this happens? Why does the sound become the loudest?

Answer: Resonance in air column. Frequency of vibrating tuning fork becomes equal to the frequency of vibrating air column. As a result, amplitude of the sound produced increases. Since loudness is proportional to square of amplitude, so sound is loudest.

Question 58: When a tuning fork, struck by a rubber pad, is held over a length of air column in a tube, it produces a loud sound for a fixed length of the air column. Name the above phenomenon. How does the frequency of the loud sound compare with that of the tuning fork? State the unit for measuring loudness.

Answer: Resonance‵Frequency of loud sound is either equal to or an integer multiple of the natural frequency of tuning fork. Decibel.

Question 59: Explain a person walking past a railway line, at the middle of night hears a ringing sound alongwith the sound of his foot steps.

Answer: When the vibrations produced by the feet of the person are impressed on the rails, they vibrate with forced vibrations, thereby producing loud sound.

Question 60: State three factors on which the frequency of vibration of a stretched string depends.

Answer: (i) Length of the stretched string, (ii) Tension in the string, (iii) Mass per unit length of the string.

Question 61: What adjustments would you make for tuning a stringed instruments for it to emit a note of desired frequency?

Answer: This can be made: (i) by changing the vibrating length of string or (ii) by changing the tension on the string.

Question 62: A string stretched between its ends is made to vibrate by placing the stem of a vibrating tuning fork at its one end. State three ways how you will increase the frequency of note produced by the string.

Answer: (i) By decreasing the vibrating length of the string, (ii) By increasing the tension on the string,
(iii) By decreasing the radius of the string.

Question 63: Explain why strings of different thicknesses are provided on a stringed instrument.

Answer: So as to produce sound of desired frequency. By plucking the string of more thickness, the frequency of sound produced decreases.

Question 64: Explain Why are stringed musical instruments provided with large sound boxes?

Answer: The larger sound box contains large amount of trapped air. When the vibrations of the vibrating string are impressed upon the air, it starts vibrating with forced vibrations. As large volume of enclosed air vibrates, a loud sound is produced.

Question 65: Explain why strings of different thicknesses are provided on a stringed instrument.

Answer: So as to produce sound of desired frequency. By plucking the string of more thickness, the frequency of sound produced decreases.

Question 66: The speed of sound is more in hydrogen than in nitrogen. Is this statement true? Give a reason to your answer.

Answer: Yes. The reason is that the density of hydrogen is less than that of nitrogen and the speed of sound $V \propto 1/\sqrt{\text{Density}}$, therefore the speed of sound is more in hydrogen than in nitrogen.
V density

Question 67: How is it possible to detect the filling of a pitcher under a tap by hearing its sound at a distance?

Answer: As the water level in the pitcher increases, the length of the vibrating air column above the water surface in it decrease and hence the frequency of sound produced increases i.e., the sound gets shriller.

Question 68: Three musical instruments give out notes at the frequencies listed below. Flute: 400 Hz; Guitar: 200 Hz; Trumpet: 500 Hz. Which one of these has the highest pitch?

Answer: Trumpet (500 Hz) will have the highest pitch.

Question 69: How do you account for the fact that two strings can be used to give notes of the same pitch and loudness but of a different quality?

Answer: The 'quality' of a given note is determined not by its frequency and loudness but 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 would then be different even though their fundamental frequencies may be the same.

Question 70: What change, if any would you expect in the characteristics of a musical sound when we increase:
(i) its frequency, (ii) its amplitude.
Answer: (i) Pitch of the sound increases (ii) Loudness increases

Question 71: A type of electromagnetic wave has wavelength 50 Å. Name the wave and state one use of this type of wave.

Answer: X-rays. These are used for determining fracture of bones, hidden objects in customs at Airports.
Question 72: Name the type of waves which are used for sound ranging. Why are radio waves not audible to us?

Answer: Radio waves. These waves are not audible to us because their frequency is 3×10^4 Hz to 3×10^9 Hz. Which is more than audible range.

Question 73: What is a musical sound? Give an example.

Answer: It is a pleasant, continuous and uniform sound which is produced by a vibrating body making periodic and regular vibrations, e.g., sound produced by flute, violin etc.

Question 74: What is a noise? Give an example.

Answer: Noise is a harsh and unpleasant sound produced by a body making a succession of irregular and discontinuous disturbances, e.g., a sound produced by a stone thrown on a thin sheet, thunder of lightening, etc.

Long Answers

Question 1: When a sound is made from a distance of 18 m, in front of a tall building, it is found to get repeated again. Which phenomenon is associated with this observation? Give a brief explanation of this phenomenon?

Answer: The associated phenomenon is known as Echo. We get echoes because of the reflection of sound. The reflected sound reaches the observer after a time 2d/v, where d is the distance of the reflecting wall from the source. For the human ear. this time must be at least 0.1 second to ensure that the reflected sound does not get mixed up with the direct sound. Since the velocity of sound in air is nearly 330 ms^{-1}, we must have
$2d/330 > 0.1$
or $d > 16.5$ m
Since the building in this case, is at a distance of 18 m, we can hear the reflected sound clearly. We thus get a clear echo in this case.

Question 2: Why is an echo not heard when distance between the source of sound and reflection body is less than 10 m?

Answer:
The impression of sound lasts on the eardrum for $\frac{1}{10}$ of a second. In $\frac{1}{10}$ of a second the sound travels a distance $332 \frac{m}{s} \times \frac{1}{10} s = 33{\cdot}2$ m. Thus, the minimum distance between the source of sound and the reflecting body should be $\frac{33{\cdot}2}{2} = 16{\cdot}6$ m.
As the distance 10 m is far less than 16.6 m, therefore the ear cannot make out when the original sound had died and echo has been received. Thus, no echo is heard.

Question 3: What do you understand by (i) free (or natural) and (ii) forced vibrations?

Answer: (i) Any object when slightly disturbed from its position of rest or equilibrium vibrates with its own period irrespective of its size or shape, is said to make vibrations. The time period of said vibrations is called natural time period and the frequency is called natural frequency. In the absence of any resistance such as air, the amplitude of free vibration remains constant.
(ii) Sometimes to keep a body vibrating, a periodic force is applied on it. In such a case, the body does not vibrate with its own natural frequency but gradually starts vibrating with the frequency of the applied periodic force. Such vibrations produced in a body are called forced vibrations, e.g., in a string of musical instrument, when the vibrations producing a loud sound.

Question 4: The rear view mirror of a motor bike starts vibrating violently at some particular speed of the motor bike.

Answer: (i) The frame of a motor cycle along with the rear view mirror is found to vibrate viotently when it is driven to a particular speed. This happens when the frame has the natural frequency of vibration equal to that of the piston when the engine is driven at that particular speed.
(ii) This phenomenon is called 'resonance'. In this phenomenon when a body begins with the natural frequency of the others vibrating body B, then A begins to vibrate violently with the maximum amplitude.
(iii) This can be stopped by mounting the engine on such a structure, say steel springs that absorbs the vibrations of the engine without communicating them to the frame and in this condition the rear view mirror attached to the frame will not vibrate violently.

Question 5: What are the factors that affect the frequency of a vibrating string and how do they affect the frequency?

Answer: The frequency (f) of a vibrating string is affected by:

(i) The length of the vibrating string. Frequency is inversely proportional to the length, *i.e.,* $f \propto \frac{1}{l}$. It means, if length increases, frequency becomes less and if length decreases, frequency increases.
(ii) It is directly proportional to the square root of the tension, other factors remaining same, *e.g.,* if tension (or stretching force) is made 4 times, then the frequency will be $(\sqrt{4} = 2)$ doubled.
(iii) The frequency, (f) is inversely proportional to the square root of the mass of unit length of the vibrating string, *i.e.* $f \propto \frac{1}{\sqrt{m}}$, if '$m$' is the mass of unit length of the string. Since 'm' $= \pi r^2 . l$, it shows that f is $\propto \frac{1}{\sqrt{r^2}}$ or $\frac{1}{r}$, where r is the radius of the vibrating string.

Question 6: What is meant by the 'pitch' of a note? Does it depend on the loudness or 'quality' of the 'note'? How is pitch 'related' with frequency?

Answer: The pitch of a note is determined solely by its frequency. The pitch in fact, is a subjective sensation in the ear depending only upon the frequency of the musical sound and is quite independent of its loudness or quality. Pitch is thus a subjective phenomenon and cannot be physically measured. However, the relation between pitch and frequency is linear to a very close approximation. Hence pitch is usually taken to be synonymous with frequency. Generally notes of high frequency or pitch are shrill and sharp whereas those of low frequency or pitch are flat and dull.

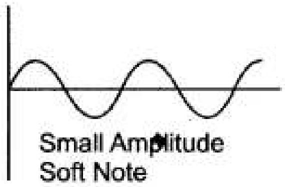
Question 7: What is meant by the 'loudness' of a sound? How is it related to the intensity?

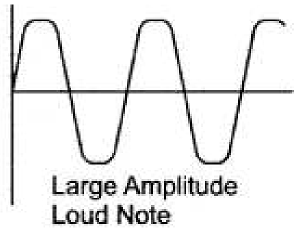
Answer: Loudness is an aural sensation, i.e., a physiological rather than a physical phenomenon. It increases with intensity but the relation between the two is not linear, i.e., the ear does not recognise a sound, having twice the intensity of another, as twice as loud. In fact loudness (L) of a sound and its intensity (I) are related as $L = k \log (I/I_0)$. Here I/I_0 is the intensity level of the sound or the ratio between its intensity I and the zero of intensity or the threshold intensity I_0 and k, a constant of proportionality depending upon the unit chosen.

Figure Based Short Answers

Question 1: How does the wave forms of loud note differ from a soft note? Draw diagram.

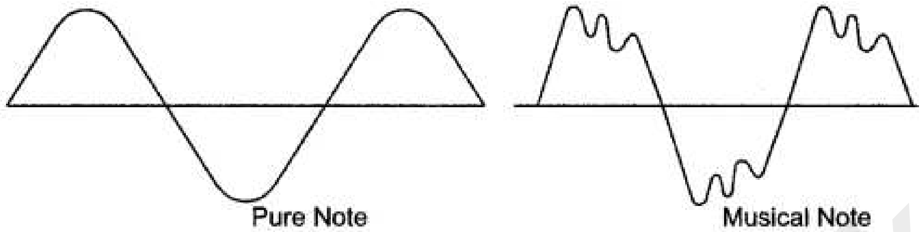
Answer: The wave form of a loud note is of larger amplitude than that of a soft note. They are shown in figure below:





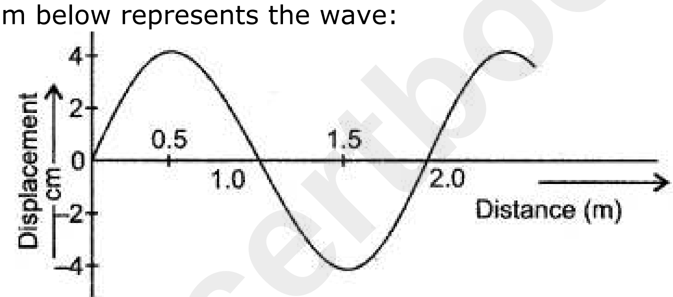
Question 2: Draw a diagram to show the wave forms of a pure note and a musical note, of same pitch and same loudness.

Answer: The figure below shows the wave forms:



Question 3: Draw a diagram representing a wave of amplitude 4 cm and wavelength 2 m. If frequency of wave is 150 Hz, calculate its velocity.

Answer: The diagram below represents the wave:



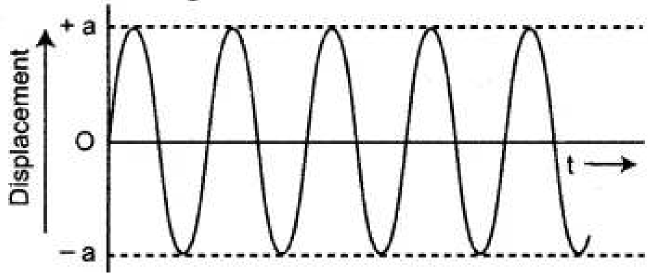
Given : $f = 150$ Hz, $\lambda = 2$ m

$\therefore$ $V = f\lambda = 150 \times 2 = 300\ ms^{-1}$.

Question 4: What do you understand by free vibrations of a body? Draw a displacement-time graph to represent them. Given one example.

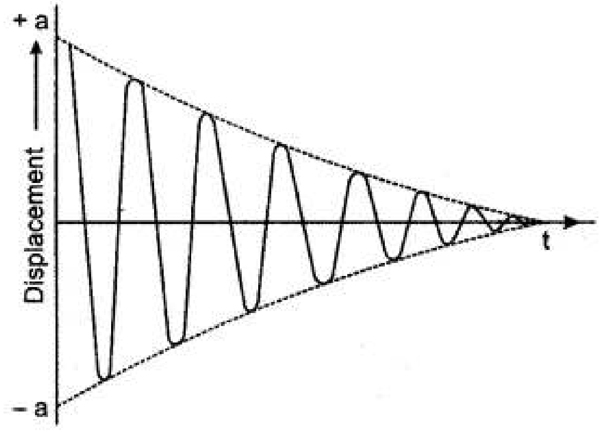
Answer: The periodic vibrations of a body, of constant amplitude and constant frequency; are called free vibrations. The displacement-time graph to represent free vibrations of a body is given in figure.

Example : A tuning fork vibrating in vacuum.

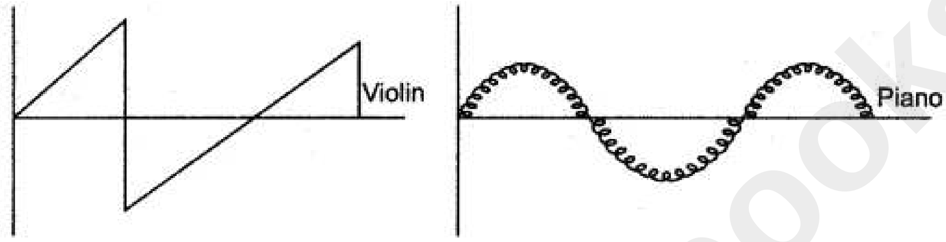


Question 5: Draw a displacement time graph to illustrate damped vibrations.

Answer: The displacement time graph showing damped vibration is given in figure below:



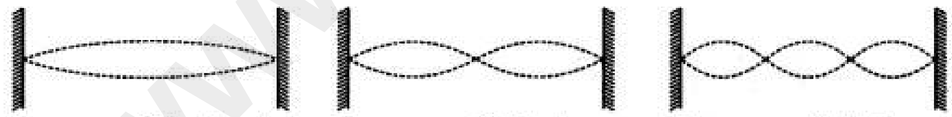
Question 6: Two musical notes of the same pitch and loudness are played on a violin and a piano. Their waveforms are as shown in the figure below:



Answer: Through the musical notes of the same pitch and loudness are played on a violin and a piano but their wave patterns are different because the waveform depends upon the number of overtones and their relative intensities.

Question 7: The frequency of stretched string of a fixed length is f when it is plucked in the middle. Where should it be plucked so that string vibrates with frequency (i) 2f, (ii) 3f? Draw diagrams to show these vibrations and name them.

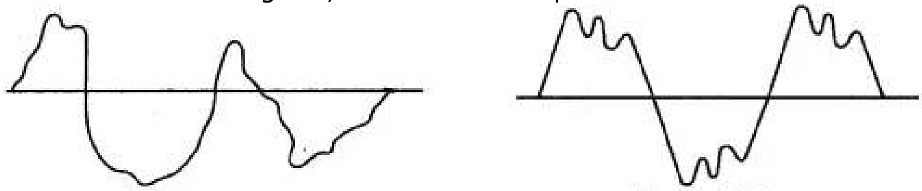
Answer: (i) The stretched string should be plucked at one-fourth part of the string to obtain frequency 2f:
(ii) The string should be plucked at one-sixth part of the string to obtain frequency 3f.
These vibration are shown in figure and are named as fundamental, first overtone and second overtone respectively.



Frequency-f Fundmental tone | Frequency=2f, First over tone | Frequency-2f First over tone

Question 8: In what respect does wave forms of a noise and a musical note differ. Draw diagrams to illustrate your answer.

Answer: The wave form of a noise is irregular, discontinuous and non-periodic while the wave form of a musical note is regular, continuous and periodic. These wave forms are shown in figure given below:

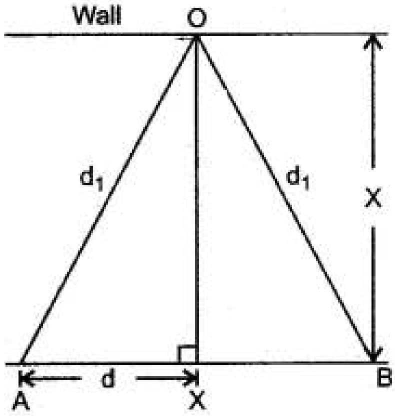


Noise | Musical Note

Figure Based LongAnswers

Question 1: A cannon is fired at A (see diagram). An observer at B hears two sounds. The first sound is heard after 1 second and the second 3s after the observer sees the flash. (Velocity of sound = 340 ms^{-1})
(i) Why does the observer see the flash before he hears the sound?
(ii) Calculate the distance x between the observer and the wall.

Answer: (i) An observer sees the flash first and hears the sound afterwards because the velocity of light which is equal to 3×10^8 ms^{-1} is much higher than the velocity of sound which is 340 ms^{-1}.



(ii) $$V = \frac{3d_1}{t}$$

An echo or the second sound is heard after 3s. $\therefore t = 3s$

$$\therefore \quad 340 = \frac{3d_1}{3}$$

$$\therefore \quad d_1 = \frac{340 \times 3}{2} = 510 \text{ ms}^{-1}$$

In right ΔAOX: $d_1^2 = OX^2 + d^2 = x^2 + d^2$

$\therefore \quad d_1^2 - d^2 = x_2$ ...(i)

but $2d = v \times t$ (where $t = 1s$)

$2d = 340$ ($v = 340$ ms^{-1} and $t = 1s$)

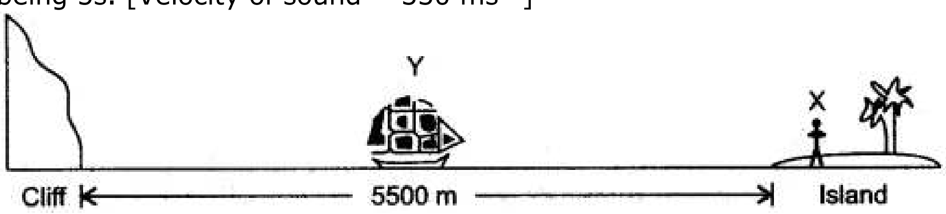
$\therefore \quad d = 170$ m ...(ii)

From equation (i) and (ii), $x = (510)^2 - (170)^2 = 10\sqrt{2312}$

$\therefore \quad x = 481$ m

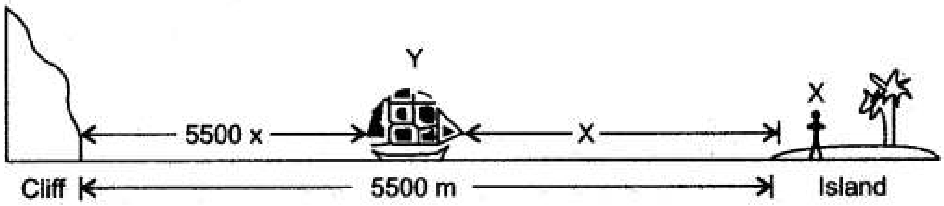
The distance between the observer and the wall is 481 m.

Question 2: An observer X is on an island 5500 m from a vertical cliff on the shore. A ship Y is anchored between the island and the Cliff. A blast on the ship's siren is heard twice by X, the interval being 5s. [Velocity of sound = 330 ms^{-1}]



(i) Find the distance of the ship from the island.
(i) Find the distance of the cliff from the ship.

Answer: (i) Let distance between the observer X on island and the ship Y = x m
Distance between the ship Y and the cliff = (5500 – x) m



Let t_1 be the time at which the first blast is heard.

$$\therefore \quad t_1 = \frac{x}{v} = \frac{x}{330} \quad \left(v = \frac{\text{Distance}}{\text{Time}}\right)$$

Let t_2 be the time at which the second blast is heard i.e., time taken for the sound to travel from the ship to the cliff and then back to the observer on the island.

$$\therefore \quad t_2 = \frac{\text{Total distance travelled}}{\text{Velocity}}$$

$$\therefore \quad t_2 = \frac{11000 - x}{330} \quad \text{...(ii)}$$

Total distance = Y to cliff + Cliff to the island

Total distance = $(5500 - x) + 5500$
= $(11000 - x)$

but $t_2 - t_1 = 5s$

∴ Subtracting equation (i) from equation (ii) we get

$$\frac{11000 - x}{330} - \frac{x}{330} = 5$$

$$\therefore \quad 11000 - 2x = 5 \times 330$$

$$\therefore \quad 2x = 11000 - 1650$$

$$= 9350$$

$$x = 4675\ m.$$

∴ Distance between the ship Y and the island = 4675 m.

(ii) Distance between ship Y and the cliff

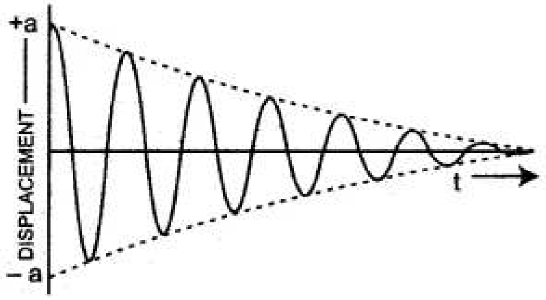
$$= 5500 - x$$

$$= 5500 - 4675$$

$$\therefore \quad x = 825.$$

Distance of the ship from the island is 4675 m and the distance of the cliff from the ship is 825m.

Question 3: The diagram below shows the displacement-time graph a for a vibrating body.

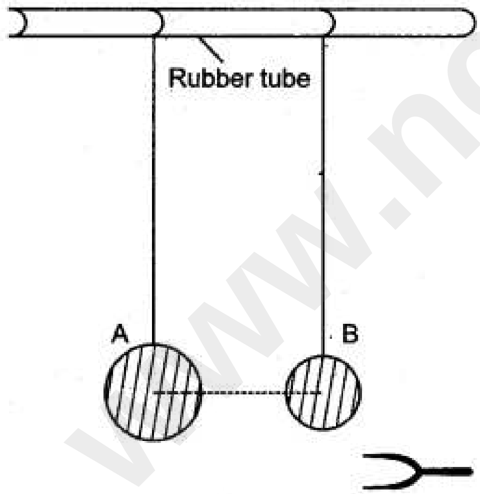


(i) Name the type of vibrations produced by the vibrating body.
(ii) Give one example of a body producing such vibrations.
(iii) Why is the amplitude of the wave gradually a decreasing?
(iv) What will happen to the vibrations of the body after some time?

Answer: (i) The diagram shows damped vibrations.
(ii) A tuning fork vibrating in air.
(iii) The amplitude of the wave decreases due to frictional force which the surrounding medium exerts on the vibrating body.
(iv) After some time the amplitude gradually decreases and finally stops.

Question 4: Explain free and forced vibrations. Give an experimental arrangement to illustrate the phenomenon of resonance.

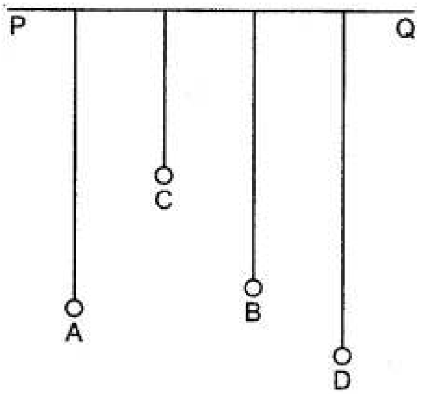
Answer: When a system or a body vibrates without receiving impulses from another system or body, its vibrations are said to be free vibrations. However, when a system or body vibrates on account of impulses received from another system or body, the vibrations are called forced vibrations. In such a case the body or the system vibrates with the frequency of the impulses received and not with its natural frequency.



Experiment Arrangement to illustrate Resonance: In figure, the two pendulums have exactly equal lengths. However, the bob of the pendulum A is heavier. Displace the bob of the pendulum A by a little distance in a direction perpendicular to the plane containing the two pendulums. Then release the bob. The pendulum A will begin to oscillate. After a short while you will find that the pendulum B also begins to vibrate. Note that the two pendulums have the same frequency. The pendulum A through the rubber tube applies impulses of the same frequency on the pendulum B Hence, the pendulum B begins to vibrate.

Question 5: Describe a simple experiment to illustrate the phenomenon of resonance and explain it.

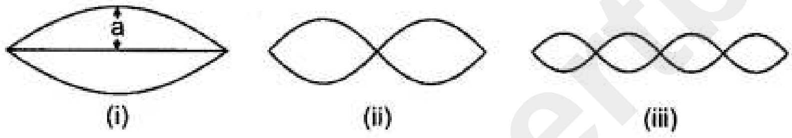
Answer:



Four pendulums A,B,C and D are suspended from a rubber string PQ. The pendulums A and B are of equal lengths while C is shorter and D is longer. The pendulum A is set into vibration. It is observed that the pendulum B also starts vibrating and ultimately acquires the same amplitude as that of A. The pendulums C and D also vibrate, but with smaller amplitudes. The pendulum B is said to be in resonance with pendulum A.

Explanation: The natural frequency of pendulum B is equal to the frequency of vibration of pendulum A since both are of equal lengths. So the forced vibrations caused in pendulum B are in resonance with vibrations of pendulum A. On the other hand, the natural frequency of pendulum C is higher while of D is smaller than that of pendulum A. So these pendulums vibrate with the frequency of pendulum A with smaller amplitudes due to forced vibrations.

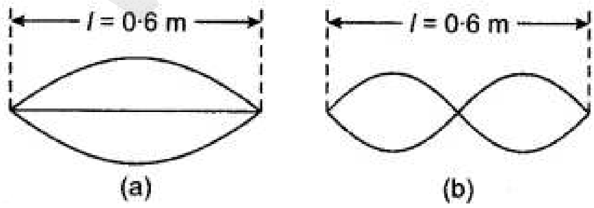
Question 6: The diagram below shows three ways in which the string of an instrument can vibrate.



(i) Which of the above diagrams shows the fundamental note?
(ii) Which has the frequency 4 times that of the fundamental?
(iii) State the ratio between the frequency of the first and second.

Answer: (i) The diagram (i) represents the fundamental note because its frequency is lowest and amplitude maximum.
(ii) The diagram: (ii) represents the sound note having frequency four times that of the (i) or fundamental.
(iii) The frequency: (ii) is two times of the frequency of (i) so the ratio between the frequencies of (i) and (ii) is 1 : 2.

Question 7: A 0.6 m long stretched wire is made to vibrate in two different modes as shown in figure (a) and (b).

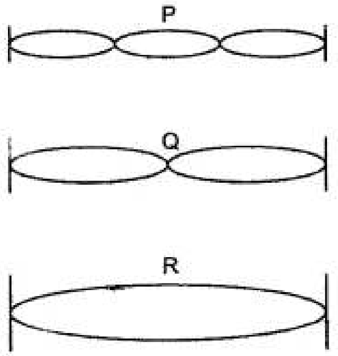


(i) If the frequency of the note produced in (b) is n, what is the frequency in case (a).
(ii) In which case (a) or (b), is the note louder? Give reasons.
(iii) In which case is the pitch higher? Give reason.

Answer: (i) The frequency of the note represented by (n) is 2 times represented by (a). Since the frequency of the note in (b) is n, hence the frequency of note in (i) is 1/2 or n/2.

(ii) The note in (a) is louder, the reason being its amplitude is greater than the amplitude of note represented in (b), as the loudness being directly proportional to amplitude.
(iii) Pitch is directly proportional to the frequency of sound note. The frequency of note in figure (b) is more (double) than the frequency of note in (a). So the pitch of note (b) is higher than that of note (a).

Question 8: The adjacent diagram shows three 'different modes of vibrations P, Q and R of the same string.



(i) Which vibration will produce a louder sound and why?
(ii) The sound of which string will have maximum shrillness?
(iii) State the ratio of wavelengths of P and R.

Answer: (i) Vibration R as its amplitude is high as loudness $\propto A^2$
(ii) Sound of string 'P' will have maximum shrillness as its frequency is maximum.
Pitch $\propto$ frequency.
(iii) $\lambda_P : \lambda_R = 3 : 1$

Short Numericals

Question 1: A radio signal, sent towards the surface of the moon, is received in 2.5 seconds. If the speed of the radio waves is 3×10^8 ms^{-1}, find the distance of the moon from the earth.

Solution: Let 'd' be the required distance. The radio waves then travel a total distance 2d (to and from moon) in 2.5 second.

Hence,

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

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

$$= 3.75 \times 10^8 \text{ metre.}$$

Question 2: A sound made on the surface of a lake takes 3 s to reach a boatman. How much time will it take to reach a diver inside the water at the same depth?
Velocity of sound in air = 330 ms^{-1}
Velocity of sound in water = 1450 ms^{-1}

Solution:

$$\because \quad s = \frac{d}{t}$$

$$\Rightarrow \quad 330 = \frac{d}{3}$$

$$\Rightarrow \quad d = 990 \text{ m}$$

Now for the diver inside water

$$s = \frac{d}{t}$$

$$t = \frac{990}{1,450}$$

$$\therefore \quad t = 0.682 \text{ sec.}$$

Question 3: Two waves of the same pitch have their amplitudes in the ratio 2 : 3.
(i) What will be the ratio of their loudness?
(ii) What will be the ratio of their frequencies?

Solution:

(i) Given, Amplitude ratio, $a_1 : a_2 = 2 : 3$

$$\because \quad I \propto a^2$$

$$\therefore \quad \frac{I_1}{I_2} = \frac{a_1^2}{a_2^2} = \frac{2^2}{3^2} = \frac{4}{9}$$

$$\Rightarrow \quad I_1 : I_2 = 4 : 9$$

(ii) $\because$ Frequency $\propto$ Pitch

$\therefore$ Ratio of frequencies $= 1 : 1$

Question 4: The smoke from the gun barrel is seen 2 second before the explosion is heard. If the speed of sound in air is 340 ms^{-1}, calculate the distance of the observer from the gun. State the approximation used.

Solution: The light has a much larger speed (= 3×10^8 ms^{-1}) in comparison to the sound (= 340 ms^{-1}), therefore we can assume that the light takes negligible time and the sound takes 2 second to reach the observer.

$$\text{Now} \quad \text{Speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

$$\therefore \quad \text{Distance} = \text{Speed} \times \text{Time}$$

$$= 340 \times 2 = 680 \text{ m.}$$

Question 5: A boy standing infront of a wall at a distance 17 m produce 10 claps per second. He notices that the sound of his clapping coincides with the echo. Echo is heard only once when clapping is stopped. Calculate the speed of sound.

Solution: Let d be the distance of wall from the boy.
To hear the echo, sound has to travel a distance.
2d = 2 × 17 = 34 m. Ans.
Since 10 claps are produced in one second, therefore each clap is produced after 1/10 s which is equal

to the time taken for the echo to be heard (according to the question), i.e., t = 1/10 s = 0.1 s.

$$\text{Now speed of sound V} = \frac{\text{Distance travelled}}{\text{Time taken}} = \frac{34}{0.1} = 340\ \text{ms}^{-1}.$$

Question 6: An observer standing in front of a vertical wall claps 10 times one second. He adjusts his distance from the wall in such a way that the second of his clapping coincides with the echo. This happens when bis distance from the wall is 17.5m. What is the velocity of sound heared by him?

Solution: Given: d = 17.5m
An observer claps 10 times in one second, i.e., he claps at an interval of 1/10th of a second or 0.1 s.
As the sound of the echo coincides with the clap this means that the echo is heard after 0.1s.

Therefore,
$$t = 0.1s$$
$$v = \frac{2d}{t} = \frac{2 \times 17s}{0.1} = 350\ \text{m/s}.$$

Question 7: A person fires a gun while standing at a distance of 850 m from a building. If the speed of sound is 350 ms, calculate the time in which the person hears an echo of the gun flte.

Solution:

$$\text{Speed of sound in air} = 350\ \text{ms}^{-1}$$
$$\therefore \quad \text{Time in which echo is heard, } t = \frac{2d}{v} = \frac{2 \times 850\ \text{m}}{350\ \text{ms}^{-1}} = 4{\cdot}86\ \text{s}.$$

Question 8: A boy stands 66.4 m in front of a high wall and then blows a whistle. Calculate the time interval when he hears an echo. (Speed of sound = 332m/s).
Solution:
Given:
$$d = 66.4m$$
$$v = 332\ \text{m/s}$$
For an echo the distance travelled by the sound is $2d$
$$\text{Time} = \frac{2d}{v} = \frac{2 \times 66.4}{332} = 0.45\ \text{second}.$$

Question 9: A ship which is stationary at a distance of 680 m from the shore, sends a signal to the coast. Its echo is heard in 4s. Find the velocity of sound.

Solution:
$$d = 680\ \text{m}$$
$$t = 4\text{s}$$
Sound takes 4s to travel to and fro *i.e.,* in 4s the distance travelled is 2×680 m.
$$\therefore \quad v = \frac{2d}{t} = \frac{2 \times 680}{4} = 340\ \text{m/s}.$$

Question 10: An observer stands at a distance of 850 m from a cliff and fires a gun. After what time gap will he hear the echo? If sound travels at a speed of 350 m/sec., in air.

Solution:

Given : $d = 850$ metre, $t = ?$, speed $v = 350$ m/sec

$\therefore \quad t = \dfrac{2d}{v}$

$\Rightarrow \quad t = \dfrac{2 \times 850}{350} \Rightarrow t = \dfrac{2 \times 17}{7} = 4{\cdot}86$ sec.

Question 11: The wavelèngth and frequency of sound wave in a certain medium is 40 cm and 835 Hz respectively. In the same medium if another wave has wavelength equal to 32 cm, calculate its frequency.

Solution:

Given : $\lambda = 40$ cm $= 0.40$ m, $f = 835$ Hz

$V = f \times \lambda = 825 \times 0.40 = 334\ ms^{-1}$

In the second case, since medium is same so the velocity of sound will remain the same.

Now $V = 334\ ms^{-1}$, $\lambda = 32$ cm $= 0.32$ m

From $\quad V = f\lambda$

$\therefore \quad f = \dfrac{V}{\lambda} = \dfrac{334}{0.32} = 1043.75$ Hz.

Question 12: A pendulum has a frequency of 5 vibration per second. An observer starts the pendulum and fires simultaneously and he hears the echo from a cliff after 8 vibrations of the pendulum. If the velocity of sound in air is 340 m/sec, what is the distance between the cliff and the observer?

Solution:

Given : Frequency of pendulum = 5 vibration/sec.

$\therefore$ Time taken $= \dfrac{8}{5} = 1{\cdot}6$ sec.

and Velocity of sound = 340 m/sec.

But $d = \dfrac{v \times t}{2} = \dfrac{340 \times 1{\cdot}6}{2}$

$\therefore \quad d = 272{\cdot}0$ m/sec.

Question 13: A radar sends a signal to an aircraft at a distance of 30 km away and receives it back after 2×10^{-4} second. What is the speed of the signal?

$\because$ Speed, $v = \dfrac{2d}{t}$

$\Rightarrow \quad v = \dfrac{2 \times 30 \times 10^3}{2 \times 10^{-4}}$

$\Rightarrow \quad v = \dfrac{30 \times 10^3}{10^{-4}}$

$\Rightarrow \quad v = 3 \times 10^4 \times 10^4$

$\therefore$ Speed of the signal, $v = 3 \times 10^8$ m/s

Question 14: An observer stands at a certain distance away from a cliff and produces a loud sound. He hears the echo of the sound after 1.8 s. Calculate the distance between the cliff and the observer if the velocity of sound in air is 340 m^{-1}.

Solution:

We know $s = \frac{d}{t}$

$\Rightarrow \quad d = s \times t$

$\Rightarrow \quad d = 340 \times \frac{1\cdot8}{2}$

$\therefore \quad d = 306$ m.

Question 15: A man standing between two cliffs produces a sound and hears two successive echoes at intervals of 3 s and 4 s respectively. Calculate the distance between the two cliffs. The speed of sound in the air is 330 ms^{-1}.

Solution:

$\because$ Ist echo is heard from the nearest cliff so let its distance be d_1

$\therefore \quad d_1 = s \times t = 330 \times \frac{3}{2} = 495$ m

and $\because$ IInd echo is heard from farther cliff so let it be d_2

$\therefore \quad d_2 = s \times t = 330 \times \frac{4}{2} = 660$ m

$\therefore$ Total distance $= 660 + 495 = 1155$ m.

Question 16: An instrument is able to detect the reflected waves from an enemy aeroplane, after a time interval of 0.02 milliseconds. If the velocity of the waves is 3×10^8 ms^{-1}, calculate the distance of the plane from the radar.

The distance of the plane from the radar is

$$\begin{aligned} \text{Distance} &= \text{Velocity} \times \text{Time} = 3 \times 10^8 \times 0\cdot02 \times 10^{-3} \text{ m} \\ &= 0\cdot06 \times 10^5 \text{ m} = 6 \times 10^3 \text{ m} \\ &= 6 \text{ kilometres.} \end{aligned}$$

Long Numericals

Question 1: A man stand in between of two parallel cliffs and blows a whistle. He hears first echo after 0.6s and second echo after 2.4s. Calculate the distance between cliffs.
[Speed of sound = 336 m/s]

Solution:

Given : t_1 = Time after which first echo is heard = 0.6s

t_2 = Time after which second echo is heard 2.4s

v = Velocity of sound = 336 m/s.

For an echo the distance travelled by the sound is $2d$.

$$d_1 = \frac{v \times t_1}{2}$$

Or, $$d_1 = \frac{336 \times 0.6}{2} = 100.8 \text{ m}$$

And $$d_2 = \frac{v \times t_2}{2}$$

Or, $$d_2 = \frac{336 \times 2.4}{2} = 403.2 \text{ m}$$

∴ Total distance between two cliffs

$$= d_1 + d_2 = (100.8 + 403.2)\text{m} = 504 \text{ m}.$$

Question 2: A boy stands in from of a cliff on the other side of a river. He fires a gun and hears an echo after 6 seconds. The boy then moves backward by 170 m and again fires the gun. He hears an echo after 7 seconds. Calculate (i) width of river, (ii) speed of sound.

Solution:

Let the width of river = x

(i) When the boy stands on the bank of river

Now, $$V = \frac{2d}{t}$$

$$V = \frac{2x}{6} \quad \text{... (a)}$$

(ii) When the boy moves 170 m away from bank.

Distance of boy from cliff = $x + 170$

Now $$V = \frac{2x}{t}$$

Or $$V = \frac{2(x + 170)}{7} \quad \text{... (b)}$$

Comparing (a) and (b)

$$\frac{2x}{6} = \frac{2x + 340}{7}$$

$$14x = 12x + 2040$$

$$x = 1020 \text{ m}$$

Width of river = 1020 m.

Substituting value of x in (i)

$$V = \frac{2 \times 1020}{6}$$

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

Question 3: A person standing between two vertical cliffs and is 640 m away from the nearest cliff. He shouted and heard the first echo after 45s and the second echo after further 3s. Calculate the speed of sound in air and the distance between the cliffs.

Solution:

Given $d_1 = 640\text{m}; t_1 = 4s$

$$t_2 = 4 + 4 = 7$$

First echo is heard from the nearest cliff.

$$\text{Total distance travelled} = 2d = 2 \times 640 = 1280 \text{ m}$$

$$v = \frac{2d_1}{t_1} = \frac{1280}{4} = 320 \text{ m/s}$$

Second echo is heard from the first cliff

$$v = \frac{2d_2}{t_2}$$

$$\Rightarrow \quad 320 \text{ ms}^{-1} = \frac{2d_2}{7}$$

$$d_2 = \frac{320 \times 7}{2} = 1120 \text{ m}$$

Hence, the distance between two cliffs

$$d_1 + d_2 = 640 + 1120 = 1760 \text{ m.}$$

Question 4: A man standing in front of a vertical cliff fires a gun. He hears an echo after 35s. On moving close to the cliff by 82.5 m he fires again. This time he hears the echo after 2.55s. Calculate the speed of sound, distance and initial position of man from the cliff.

Solution:

Given :

$$t = 35, d = x \, m$$

$$t_1 = 2.55s, d_1 = (x - 82.5)\text{m}$$

$$v = \frac{2d}{t} = \frac{2x}{3} \quad \text{... (i)}$$

$$v = \frac{2d_1}{t_1} = \frac{2x - 165}{2.5} \quad \text{... (ii)}$$

Comparing (i) and (ii)

$$\frac{2x}{3} = \frac{2x - 165}{2.5}$$

or

$$5x = 6x - 165 \times 3$$

$$x = 495\text{m}$$

Substituting this value in (i)

$$v = \frac{2 \times 495}{3} = 330 \text{ m/s.}$$

Question 5: Waves produced on the surface of water are formed to move with a velocity of 24 ms^{-1}. If the wavelength of these waves equals 20 cm. find the

(i) frequency (no. of waves produced per second)

(ii) the time period (i.e. the time required to produce one wave) for these waves.

Solution:

(i) We have,

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

$$24\ \text{ms}^{-1} = n \times (20 \times 10^{-2}\ \text{m})$$

or

$$n = \frac{24}{24 \times 10^{-2}} = 120 \text{ per second.}$$

(ii)

$$\text{Time period} = \frac{1}{\text{Frequency}} = \left(\frac{1}{120}\right)\text{sec.} = 0{\cdot}00833 \text{ sec.}$$

Approximate frequency range of sound waves is about 15 to 200,000 Hz.

Question 6: A man standing 25 m away from a wall produces a sound and receives the reflected sound.

(i) Calculate the time after which he receives the reflected sound if the speed of sound in air is 350 ms^{-1}.

(ii) Will the man be able to hear a distinct echo? Give a reason for your answer.

Solution:

(i) $\because$

$$S = \frac{d}{t}$$

$\Rightarrow$

$$350 = \frac{50}{t}$$

$\therefore$

$$t = \frac{1}{7} \text{ sec} = 0{\cdot}14 \text{ sec.}$$

(ii) Echo will be heard because the conditions required for the formulation of echo are fulfilled.

(a) 17 m minimum distance should be there.

(b) Persistence of hearing is 0.1 sec.

As both the conditions are satisfied. So echo will be heard.

Question 7: (i) A man stands at a distance of 68 m from a cliff and fires a gun. After what time interval will he hear the echo, if the speed of sound in air is 340 ms^{-1}?

(ii) If the man had been standing at a distance of 12 m from the cliff would he have heard a clear echo?

Solution:

(i) $d = 68$ m,, $v = 340\ \text{ms}^{-1}$.

$\therefore$

$$\text{Time taken} = \frac{\text{total distance}}{\text{speed}} = \frac{68}{340} = \frac{1}{5} = 0{\cdot}2 \text{ s (second)}$$

So echo is heard after $2t$ *i.e.*

$$0{\cdot}2 \times 2 = 0{\cdot}4 \text{ sec.}$$

(ii) If man had been standing at a distance 12 m then

$$t = \frac{2d}{v} = \frac{2 \times 12}{340} = \frac{24}{340} = 0{\cdot}07 \text{ sec.}$$

which is less than 0·1 sec.

Hence, man can not hear a clear echo.

Question 8: A sound wavelength of 0.332 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.

Solution:

$$\text{Wavelength} = \lambda = 0.332\ m$$
$$\text{Time period} = T = 10^{-3}\ s$$
$$\text{Frequency} = \frac{1}{T} = \frac{1}{10^{-3}} = 10^3\ \text{Hz.}$$

Now the time period is decreased and is now 10^{-4} s.

$$\therefore \quad \text{New frequency} = \frac{1}{10^4} = 10^{-4}\ \text{Hz,}$$
$$\text{Speed of sound, V} = f \times \lambda = 10^3 \times 0.332$$
$$= 332\ \text{m/s}$$

Since, speed remains the same

$$\therefore \quad \text{New wavelength, } \lambda = \frac{V}{f} = \frac{332}{10^4} = 0.0332\ \text{m.}$$

Question 9: What could be done to stop the violent vibrations?

Solution:

$$\text{Wavelength} = \lambda = 0.332\ \text{m}$$
$$\text{Time period} = T = 10^{-3}\ s$$
$$\text{Frequency} = \frac{1}{T} = \frac{1}{10^{-3}} = 10^3\ \text{Hz}$$

Now the time period is decreased and is now 10^{-4} s.

$$\therefore \quad \text{New frequency} = \frac{1}{10^4} = 10^{-4}\ \text{Hz}$$
$$\text{Speed of sound, V} = f \times \lambda = 10^3 \times 0.332$$
$$= 332\ \text{m/s}$$

Since, speed remains the same

$$\therefore \quad \text{New wavelength, } \lambda = \frac{V}{f} = \frac{332}{10^4}$$
$$= 0.0332\ \text{m.}$$