Chapter 3. Sound

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Solution 1

Longitudinal waves
1. As it travels through a medium, the particles of the medium vibrate to and fro about their mean positions along the direction of propagation of wave.
2. As the wave propagates through the medium, it causes compression’s and rarefaction’s.
3. In case of longitudinal waves, one wavelength contains one compression and one rarefaction.
4. They can travel through all media i.e. solids, liquids and gases.
5. As the longitudinal wave propagates through a medium, there is change in density of the medium.

Transverse waves
1. As it travels through a medium, the particles of the medium vibrate perpendicular to the direction of propagation of wave.
2. As the wave propagates through the medium, it produces crests and troughs.
3. In case of transverse waves, one wavelength contains one crest and one trough.
4. They can travel only through solids and on the surface of liquids.
5. As the transverse wave travels through a medium, there is no change in density of the medium.

Longitudinal waves	Transverse waves
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Solution 2

The amplitude of an oscillation is the height of a crest or the depth of a trough measured from the mean position. The SI unit of amplitude is metre.

Solution 3

Wave-velocity = wavelength x frequency

Solution 4

The velocity of a wave in a medium depends on the elasticity and density of the medium.

Solution 5

The velocity of a wave increases with the increase in temperature.

Solution 6

Ans6

$v = \lambda f$

$\therefore \lambda = \frac{v}{f} = \frac{350}{700} = 0.5 \text{ m}$

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Solution 7

A longitudinal wave propagates by means of compressions and rarefactions.When a vibrating object moves forward, it pushes and compresses the air in front of it creating a region of high pressure. This region is called a compression (C), as shown in Fig. This compression starts to move away from the vibrating object. When the vibrating object moves backwards, it creates a region of low pressure called rarefaction (R), as shown in Fig.

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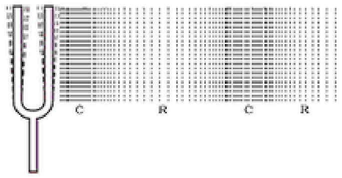

Fig. 12.5: A vibrating object creating a series of compressions (C) and rarefactions (R) in the medium.

Compressions are the regions of high density where the particles of the medium come very close to each other and rarefactions are the regions of low density where the particles of the medium move away from each other.

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Solution 8

A transverse wave propagates by means of crests and troughs.The high points of the waves are called crests or peaks and the low points of the waves are called troughs.

Solution 9

The velocity with which a wave travels in a medium is referred to as wave-velocity.

Solution 10

Sound waves are mechanical in nature.

Solution 11

Electromagnetic waves have greater speed.

Solution 12

Sound waves being mechanical waves need a material medium for their propagation, they cannot travel in vacuum.

Solution 13

Characteristics of wave motion:
1. Wave motion can be produced only in a medium having elasticity and inertia.
2. When energy is given to any part of a medium, disturbance is produced in it by repeated periodic motion of the particles about their equilibrium positions.
3. During wave motion, no matter is transferred. It is only the energy that gets transferred.
4. The velocity of the wave relative to the medium depends only on the nature of the medium and not on the nature or motion of source of disturbance.
5. The velocity of the wave is different from the velocity with which the particles of the medium vibrate about their equilibrium positions.
6. Energy gets transferred from one particle of a medium to the next particle in a fixed interval of time.
7. The energy associated with the wave is the kinetic and potential energy of the matter.

Solution 14

Yes, energy is transferred during wave motion.

Solution 15

Electromagnetic waves	Mechanical waves
1. They can travel in vacuum. 2. These are formed by the periodic vibrations of mutually perpendicular electric and magnetic field in a plane normal to the direction of wave propagation. 3. These are traverse in nature.	1. They cannot travel in vacuum. They need a material medium for their propagation. 2. These are formed by the vibrations of the medium particles about their mean positions. These vibrations can be along the direction of propagation of wave or perpendicular to it. 3. These waves can be transverse as well as longitudinal.

Solution 16
No, transverse waves cannot travel in air. They can only travel in media which posses rigidity.

Solution 17
The wavelength is the distance between two successive crests or two successive troughs on a transverse wave.It is also equal to the distance between any two points where the particles are passing through their respective mean positions in the same direction.It is also the distance between two successive compressions or two successive rarefactions on a longitudinal wave.The SI unit of wavelength is metre (m).

Solution 18
Range of hearing of a normal person is 20 Hz to 20,000 Hz which is called the range of audibility.

Solution 19
The sound heard after reflection from a rigid obstacle (such as cliff, a hillside, a wall of a building, edge of a forest etc.), is called an echo.

Solution 20
Full form of SONAR is 'sound navigation and ranging'.

Solution 21
Full form of RADAR is 'radio detection and ranging'.

Solution 22
The depth of a sea can be found by the process of 'echo depth sounding'. This process is based on the principle of 'echo formation'.

Solution 23
The sound wave of frequency higher than 20,000 Hz is called ultrasonic.

Solution 24
The sound wave of frequency below 20 Hz is called infrasonic.

Solution 25
Applications of supersonics:1. Jet aircrafts2. Rockets

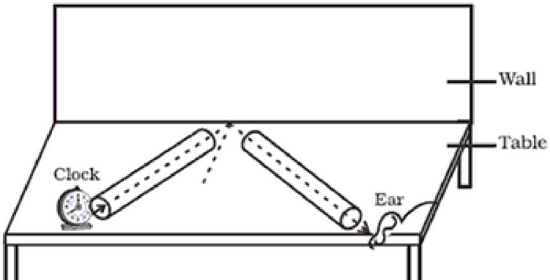
Solution 26
The sound heard after reflection from a rigid obstacle is called an echo. To hear the cho of a sound distinctly, the reflecting surface in air should be at a minimum distance of 17 m from the listener. If the distance is less than 17 m, the reflected sound will reach the ears before the original sound dies out. In such a case, the original sound mixes up with the reflected sound. Due to repeated reflections at the reflecting surface, the sound gets prolonged. This effect is known as reverberation.

Solution 27
Conditions necessary for echo formation are:1. The minimum distance between the source of sound and its reflector should be 17 m.2. Reflected sound should reach the person atleast 0.1 second after the original sound is heard.

Solution 28
The lowest frequency audible to human ear is 20 Hz and the highest frequency audible to human ear is 20,000 Hz.

Solution 29
Yes, sound waves can be reflected.

Solution 30
Experiment to demonstrate the reflection of sound:
1. Take two identical pipes, as shown in Fig. You can make the pipes using chart paper. The length of the pipes should be sufficiently long as shown.
2. Arrange them on a table near a wall.
3. Keep a clock near the open end of one of the pipes and try to hear the sound of the clock through the other pipe.
4. Adjust the position of the pipes so that you can best hear the sound of the clock.



Reflection of sound

Conclusion: Sound waves pass down the first tube and are reflected from the smooth surface of the wall. After reflection, they enter the second tube and are received by the ear at the other end. If you measure the angle of incidence and angle of reflection, you will notice that they are equal.

Solution 31
A simple method for finding the velocity of sound is echo or open air method.For example: A person stands at a known distance (d m) from a cliff and fires a pistol and simultaneously starts the stop watch. He stops the stop-watch as soon as he hears the echo. The distance traveled by sound during this time (t seconds) is twice the distance (2d m). The velocity (v) of sound is then calculated as under:
By repeating the experiment two or three times, the average velocity of sound can be calculated.

$$\text{Velocity of sound} = \frac{\text{distance travelled}}{\text{time taken}} = \frac{2d}{t}$$

Solution 32
(i) Bats can produce and detect the sound of very high frequency. The bats fly with speed much lower than the speed of sound. The sounds produced by flying bats get reflected from any obstacle in front of it. By hearing the echoes, bats come to know where the obstacles are, even in the dark. So, they can fly safely without colliding with the obstacles. This process of detecting obstacles is called sound ranging.
(ii) Dolphins detect their enemies and small fishes by emitting ultrasonic waves in all directions and then hearing their reflected sound i.e. echo. Dolphins can judge the nature of obstacles or of small fish by hearing the echo and catch their prey.

Solution 33
The process of sending ultrasonic waves in all directions to detect obstacles and hearing the echo is called sound signaling.

Solution 34
The process of detecting obstacles by sending ultrasonic waves and hearing the echo is called sound ranging.

Solution 35

Here, $t_1 = 5s$. Let d be the distance of the hill from the man and v be the velocity of sound.

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

$5 = \frac{2d}{v}$ or $d = \frac{5v}{2}$ ....(i)

When the man moves, through a distance 310 m towards the wall, then d' = d - 310 and t' = 3s.

$\therefore\ 3 = \frac{2\,(d - 310)}{v}$

or, $d - 310 = \frac{v}{2}$ ....(ii)

Subtracting (ii) from (i)

$d - d + 310 = \frac{5v}{2} - \frac{3v}{2} = \frac{2v}{2} = v$

$\therefore\ v = 310$ m/s

Solution 36

Bats can produce and detect the sound of very high frequency. The bats fly with speed much lower than the speed of sound. The sounds produced by flying bats get reflected from any obstacle in front of it. By hearing the echoes, bats come to know where the obstacles are, even in the dark. So, they can fly safely without colliding with the obstacles. This process of detecting obstacles is called sound ranging.

Solution 37

Bats, dolphins and fishermen use the principle of echo for locating obstacles and prey.They produce and sent ultrasonic waves in all directions. When these waves are reflected back from the obstacles or prey, they hear the echo. From the time taken to hear the echo and from the nature of the sound received, bats, dolphins and fishermen are able to gauge the distance and type of surroundings.

Solution 38

SONAR means sound navigation and ranging.Sonar is an instrument that makes use of ultrasonic waves for sound ranging. It is equipped to measure even short time intervals quite accurately.Sonar works on the principle of echoes. A strong and short (ultrasonic) sound signal is sent towards the bottom of ocean. The echo of this signal is then detected by it. By noting the time after which the reflected sound (echo) reaches back, we can calculate the depth of the ocean by using the formula.Depth of ocean = v x t/2, here v is the velocity of ultrasonic wave.

Solution 39

Ultrasonic waves are sent in sonar to find the depth of the sea.

Solution 40

Let A_1 and A_2 be the distances of the two cliffs from the man. then

$2\,A_1 = 320 \times 4 = 1280$ ....(i)

and, $2\,A_2 = 320 \times 6 = 1920$.............(ii)

Adding (i) and (ii)

$2\,(A_1 + A_2) = 3200$

or, $A_1 + A_2 = 1600$m

$\therefore$ distance between the two cliffs = 1600 m

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Solution 1

The propagation of wave through a medium due to the repeated oscillatory motion of the particles of the medium about their mean position, the motion being handed over from one particle of the medium to the next particle progressively is referred to as wave motion.

Solution 2

Transverse waves	Longitudinal waves
1. In these waves, the vibrations of the particles are perpendicular to the direction of wave and form crest and trough in the medium. 2. These waves can be formed only in the medium which possesses rigidity. Hence, they can travel only in solids and on the surface of liquids.	1. In these waves, the vibrations of the particles are along the direction of propagation of wave and form compressions and rarefactions in the medium. 2. These waves can travel in solids, liquid as well as gases.

Solution 3

The vibrations of a body with constant amplitude and constant frequency are called free vibrations.

Solution 4

A body clamped at one point, if disturbed slightly from its position of rest starts vibrating. The vibrations so produced are called natural vibrations of the body. The natural period or frequency of such vibrations is called frequency of vibration of a body. This frequency depends upon the shape and size of the body.

Solution 5

The periodic vibrations of body of decreasing amplitude are called the damped vibrations.

Solution 6

When the frequency of the forced vibration is equal to the natural frequency of a body nearby or an integer multiple of it then the body vibrates with a large amplitude. This phenomenon is called resonance.E.g.1 all stringed instruments are provided with sound box (or sound chamber). This box is so constructed that the column of of air inside it, has a natural frequency which is the same as that of the strings stretched on it, so that when the strings are made to vibrate, the air column inside the box is set to forced vibrations. Since the sound box has a large area, it sets a large volume of air into vibration of the same frequency as that of the string. So, due to resonance, a loud sound is produced.E.g.2 Radio and TV receivers have electronic circuits which produce electrical vibrations, the frequency of which can be changed by changing the values of the electrical components of that circuit. When we want to tune a radio or TV receiver, we merely adjust the values of the electronic components to produce vibrations of frequency equal to that of the incoming radio waves which we want to receive. When the two frequencies match, due to resonance, the energy or signal of that particular frequency is received from the incoming waves. The signal is then amplified in the receiver set.

Solution 7

(i) Diagram
(a) shows the principal note as the string in this diagram is vibrating in one loop.
(ii) Diagram
(c) has the frequency four times that of first.
(iii) The ratio of frequency of the vibration in
(a) and (b) is 1:2.

Solution 8

Music	Noise
1. It is pleasant, smooth and agreeable to the ear. 2. It is produced by the vibrations which are periodic. 3. All the component waves are similar without any sudden change in their wavelength and amplitude. 4. The sound level is low (below 30 dB).	1. It is harsh, discordant and displeasing to the ear. 2. It is produced by an irregular succession of disturbances. 3. The component wave changes their character suddenly and they are of short duration. 4. The sound level is high (above 120 dB).

Solution 9
Examples of forced vibrations:
1. When the stem of a vibrating tuning fork is pressed against the top of a table, the tuning fork forces the table top to vibrate with its own frequency. The vibrations produced in the table top are forced vibrations.
2. When a guitar is played, the vibrations produced by the strings of the guitar are the forced vibrations.

Solution 10
When an oscillatory system is made to oscillate under the action of an externally applied periodic force, it is said to execute forced vibrations. In this case the external frequency may or may not be equal to the natural frequency of the body.In case of resonance, the externally applied periodic force has the same frequency as the natural frequency of oscillation of the given oscillatory system.

Solution 11
Frequency of vibrations of a stretched string depends upon:
1. Frequency of the fundamental note of a stretched string is inversely proportional to the length of the vibrating string.
2. Frequency is directly proportional to the square root of the tension of the string.
3. Frequency is inversely proportional to the square root of linear density. That is, mass per unit length of the material of the string. Thinner is the wire, higher is the frequency.

Solution 12
Frequency of vibration of a stretched string can be increased by:
1. By increasing the tension in the string.
2. By decreasing the length of the string.

Solution 13
When a troop crosses a suspension bridge, the soldiers are asked to break steps. The reason is that when soldiers are in steps, all the separate forces exerted by them are in same phase and therefore vibrations of a particular frequency are produced. Now if the natural frequency of the bridge happens to be equal to the frequency of steps (or an integer multiple of it) the bridge will vibrate with a large amplitude due to resonance and the suspension bridge could crumble.

Solution 14
The medium offers some resistance due to which the amplitude of vibrations decreases with time.

Solution 15
No, pitch is not the same as frequency.

Solution 16
We know that the frequency of the string depends on the length, density and tension; hence the tension is changed to bring about the desired tuning because length is fixed in this case.

Solution 17
In stringed instruments frequency depends on thickness or radius of string. So to produce different frequencies different strings of different thicknesses are provided.

Solution 18
(i) No loud sound is heard with P and R but a loud sound is heard with S.
(ii) Resonance occurs with the air column in tubes Q and S whereas no resonance occurs in the air columns of tubes P and R. The frequency of vibrations of air column in the tube S is thrice the frequency of vibrations of air column in the tube Q, while the frequency of vibrations of air column in tubes P and R is neither equal to nor an integer multiple of frequency of vibrations of air column in tube Q.
(iii) When the frequency of vibrations of air column is either equal to or an integer multiple of the frequency of the vibrating tuning fork, resonance occurs.

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Solution 19

Frequency 512 Hz is twice the natural frequency of the tuning fork (256 Hz), hence the tuning fork will resonate at the frequency 512 Hz.

Solution 20

(i) If the tuning fork A is set into vibration, the other fork B also starts vibrating and a loud sound is heard.The vibrating tuning fork A produces the forced vibrations in the air column of its sound box. These vibrations are of large amplitude because of large surface area of the air in the sound box and they are communicated to the sound box of the fork B. The air column of B starts vibrating with the frequency of fork A. Since the frequency of these vibrations is same as the natural frequency of the fork B, the fork B starts vibrating due to resonance.
(ii) The principle of 'resonance' is illustrated by this experiment.Statement: When the frequency of the forced vibration is equal to the natural frequency of a body nearby or an integer multiple of it then the body vibrates with a large amplitude. This phenomenon is called resonance.

Solution 21

Observation: It is observed that the pendulum S also starts vibrating and it ultimately acquires the same amplitude as that of P and the vibrations of S are in phase with those of P (i.e. they reach their extreme positions on either side simultaneously). The pendulums Q and R also vibrate but they vibrate with smaller amplitudes.Reason: The vibrations produced in pendulum P are communicated to the other pendulums Q,R and S through the elastic string XX'. The pendulums Q and R are in the state of forced vibrations, while the pendulum S is in the state of resonance. This is because the natural period of pendulum S is equal to that of P (being of same length), and therefore resonance takes place. The pendulum S therefore vibrates with the amplitude of P and remains in phase with the pendulum A.

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Solution 1

The sound heard after reflection from a rigid obstacle (such as cliff, a hillside, a wall of a building, edge of a forest etc.), is called an echo.Conditions necessary for echo formation are:1. The minimum distance between the source of sound and its reflector should be 17 m.2. Reflected sound should reach the person atleast 0.1 second after the original sound is heard.

Solution 2

The audience in the auditorium as act obstructions in the path of sound waves; so they sound waves are not reflected much less and hence the echoes usually decrease.

Solution 3

$$\text{Velocity of sound} = \frac{\text{distance travelled}}{\text{time taken}} = \frac{2d}{t}$$

$$\therefore \text{ Velocity of sound} = \frac{2 \times 480}{2} = 480 \text{ m/s}$$

Solution 4

$$\text{Velocity of sound} = \frac{\text{distance travelled}}{\text{time taken}} = \frac{2d}{t}$$

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

Thus, the girl hears the echo after 4s.

Solution 5

Give that, speed of sound at $0^\circ = 330$ m/s

For every 1° rise in temperature, the velocity of sound increases by 0.61 m/s

$\therefore$ the velocity of sound at $10^\circ = 330 + (0.61 \times 10) = 330 + 6.1 = 336.1$ m/s

Let A_1 and A_2 be the diatances of the two walls from the point of rifle shots. Then

$2 \times A_1 = 336.1 \times 3 = 1008.3$ ....(i)

$2 \times A_2 = 336.1 \times 6 = 2016.6$...............(ii)

Adding (i) and (ii) we get :

$2\ (A_1 + A_2) = 3024.9$

or, $(A_1 + A_2) = 1512.45$ m

Thus, the width of the valley is 1512.45 m

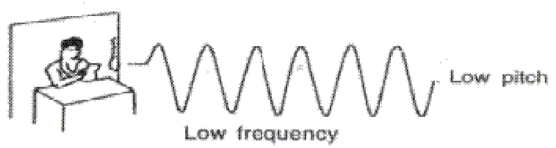
Solution 6

(a) Bats can produce and detect the sound of very high frequency. The bats fly with speed much lower than the speed of sound. The sounds produced by flying bats get reflected from any obstacle in front of it. By hearing the echoes, bats come to know where the obstacles are, even in the dark. So, they can fly safely without colliding with the obstacles. This process of detecting obstacles is called sound ranging.

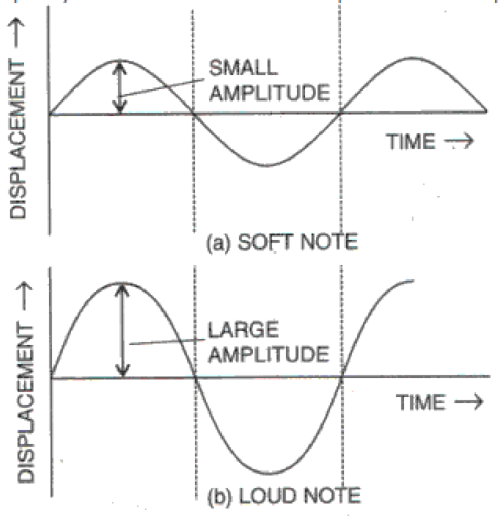
(b) Dolphins detect their enemies and small fishes by emitting ultrasonic waves in all directions and then hearing their reflected sound i.e. echo. Dolphins can judge the nature of obstacles or of small fish by hearing the echo and catch their prey.

Solution 7

(a) Frequency: Frequency of a vibrating body is defined as the number of vibrations completed by the body in one second.

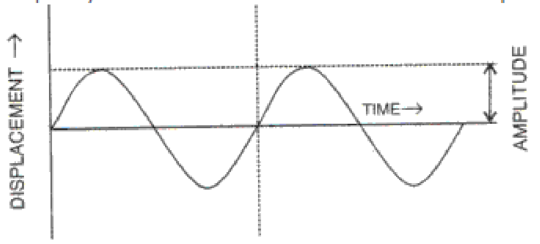


(b) Loudness: Loudness is the property by virtue of which a loud sound can be distinguished from a faint one, both having the same pitch and quality. The loudness of a sound depends on the amplitude (or intensity) of the wave.

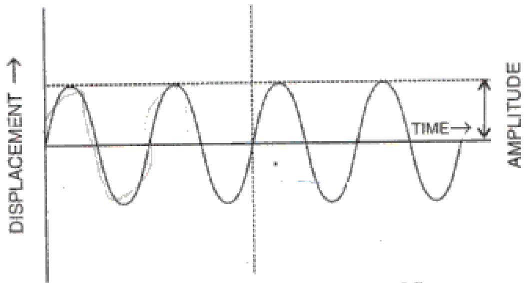


Soft and loud notes

(c) Pitch: 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 note. The relation between pitch and frequency is linear to a very close approximation.



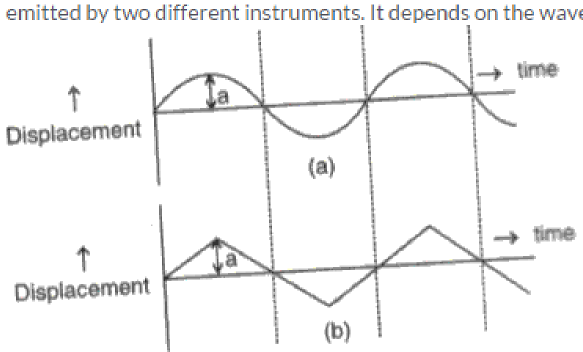
(a) LOW PITCH NOTE (Frequency = f)



(b) HIGH PITCH NOTE (Frequency = $2f$)

Waves of different pitch

(d) Quality of a musical note: quality of a sound is that characteristic which distinguishes the two sounds of the same loudness and same pitch, but emitted by two different instruments. It depends on the waveform.



Two sounds of same amplitudes (i.e., same loudness) and same frequency but of different wave forms

Solution 8

Wave- velocity: It is the velocity with which a wave propagates in a particular medium.

Wavelength: The wavelength is the distance between two successive crests or two successive troughs on a transverse wave.It is also equal to the distance between any two points where the particles are passing through their respective mean positions in the same direction.It is also the distance between two successive compressions or two successive rarefactions on a longitudinal wave.

Wave-velocity = wavelength x frequency

Solution 9

Given, velocity = 330 m/s, frequency = 256 Hz

$$\therefore \text{ Wave-length} = \frac{\text{velocity}}{\text{frequency}} = \frac{330}{256} = 1.3 \text{ m}$$

Solution 10

Pitch of a musical noted depends on its wavelength or frequency. Higher the frequency, higher the pitch.Loudness depends upon the amplitude of the wave. Loudness is directly proportional to the square of amplitude.Quality of a musical depends on the wave form.

Solution 11

(a) Wavelength = Distance between two successive crests or two successive troughs=10 cm

(b) Amplitude = Maximum displacement of the particles from the mean position = 4 cm

(c)

Velocity = frequency $\times$ wave length
Given, frequency = 50 Hz,
wavelength = 10 cm = 0.1 m
$\therefore$ Velocity = 50 $\times$ 0.1 = 5 m/s

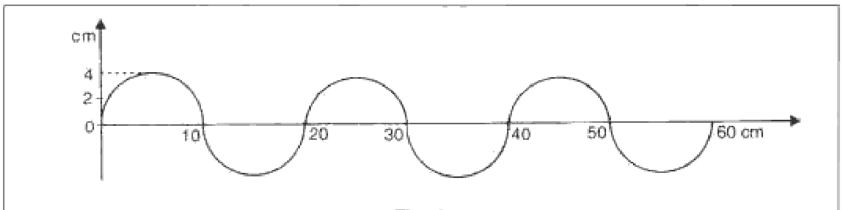


Fig. 1

Solution 12

(a)

Light waves	Sound waves
1. These are electromagnetic waves. 2. They can travel in vacuum. 3. The speed of light waves is very high (= 3 x 10^8 m/s in air). 4. The wavelength of the light waves (visible) is very small, of the order of 10^{-6} m. 5. These waves are transverse.	1. These are mechanical waves. 2. They require a material medium for propagation. 3. The speed of sound waves is low (=330 m/s in air). 4. The wavelength of sound waves is in the range of 10^{-2} m to 10m. 5. These waves are longitudinal waves.

(b)

Free vibrations	Forced vibrations
1. When a body vibrates with its natural frequency and time period which is characteristic of the body itself, it is said to have free vibrations. 2. It is difficult to realize such vibrations in practice. They can take place only in vacuum.	1. When a body is set into vibrations with the help of a strong periodic force then the vibration is said to be forced vibration. The frequency of such vibrations may not be equal to the natural frequency of the body. 2. Such vibrations can be realized in practice.

(c)

Radio waves	Light waves
1. Radio waves are not visible to human eye. 2. These waves range from 10^5 to 10^{-3} meters. 3. Frequency of radio waves is below 10^7 Hz. 4. Its sources are TV and radio transmitters.	1. Light waves are visible to human eye. 2. These waves range from 10^{-6} to 10^{-7} meters. 3. Frequency of light waves lie in the range 10^{14} to 10^{13} Hz. 4. Its sources are sunlight, white hot bodies
	etc.

Solution 13

Frequency of vibrations of a stretched string depends upon:1. Frequency of the fundamental note of a stretched string is inversely proportional to the length of the vibrating string.2. Frequency is directly proportional to the square root of the tension of the string.3. Frequency is inversely proportional to the square root of linear density. That is, mass per unit length of the material of the string. Thinner is the wire, higher is the frequency.

Solution 14

When the frequency of the forced vibration is equal to the natural frequency of a body nearby or an integer multiple of it then the body vibrates with a large amplitude. This phenomenon is called resonance.E.g.1 all stringed instruments are provided with sound box (or sound chamber). This box is so constructed that the column of of air inside it, has a natural frequency which is the same as that of the strings stretched on it, so that when the strings are made to vibrate, the air column inside the box is set to forced vibrations. Since the sound box has a large area, it sets a large volume of air into vibration of the same frequency as that of the string. So, due to resonance, a loud sound is produced.E.g.2 Radio and TV receivers have electronic circuits which produce electrical vibrations, the frequency of which can be changed by changing the values of the electrical components of that circuit. When we want to tune a radio or TV receiver, we merely adjust the values of the electronic components to produce vibrations of frequency equal to that of the incoming radio waves which we want to receive. When the two frequencies match, due to resonance, the energy or signal of that particular frequency is received from the incoming waves. The signal is then amplified in the receiver set.

Solution 15

Sounds can be roughly divided into two categories: (i) music, and (ii) noise.

Regularity, contrivity and rapidity make musical sounds different from a noise. The distinction between music and noise is not very sharp; it is subjective.

Music	Noise
1. It is pleasant, smooth and agreeable to the ear. 2. It is produced by the vibrations which are periodic. 3. All the component waves are similar	1. It is harsh, discordant and displeasing to the ear. 2. It is produced by an irregular succession of disturbances. 3. The component wave changes their
without any sudden change in their wavelength and amplitude. 4. The sound level is low (below 30 dB).	character suddenly and they are of short duration. 4. The sound level is high (above 120 dB).

Solution 16

(a)Guitar produces notes using vibrating string.To produce notes with different pitches, strings of different thicknesses are plucked. When a string of greater thickness is plucked, a note with higher pitch is produced and vice-versa.To produce the notes of different loudness, all stringed instruments are provided with hollow sound box which contains air. In these instruments vibrations are produced in the sound box when the strings on it are made to vibrate by plucking, are forced vibrations. Larger the surface area of the air in the sound box, louder will be the sound produced.

(b) Flute produces notes using a vibrating column of air.In a flute, the notes of different frequencies or pitch are produced by changing the effective length of the air column when different holes in it are closed.In a flute, the notes of different loudness can be produced by using flutes of different diameters. A flute with larger diameter shall have more air enclosed in it and hence the sound produced by it shall be louder.

(c)Piano produces notes using a vibration of any other body.When we strike the keys of piano, strings of different thickness are set in vibration at their natural frequencies; hence sound of higher pitch can be produced by striking the string of greater thickness.A piano's wires are attached to a sounding board with help of which sound of different loudness can be produced. The vibrating wire makes the board vibrate, which makes the sound louder.

Solution 17

(a)When a nail is hammered into a piece of wood, its length outside wood gradually decreases. As the length decreases, the frequency of vibrations increases and hence the pitch being directly proportional to the frequency also increases
(b)When the windows rattle, at that moment, its natural frequency corresponds with the frequency with which the low notes of a pipe organ are sounded. Thus, resonance takes place which makes the windows to vibrate violently.

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Solution 18

Sound of level below 120 dB is safe for our ears.

Solution 19

The sound level above 120 dB causes noise pollution.

Solution 20

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 note. The relation between pitch and frequency is linear to a very close approximation.

Solution 21
Subjective property of sound related to its frequency is ‘pitch’.

Solution 22
It is possible to recognize a person by his voice without seeing him because the vibrations produced by the vocal chord of each person have a characteristic waveform which is different for different persons.

Solution 23
The loudness of a sound wave is determined by its amplitude; it is proportional to the square of the amplitude. Therefore, the louder sound corresponds to the wave of larger amplitude.

Solution 24
When the strings are made to vibrate by plucking, the vibrations get transferred to the hollow sound box. As a result, the large volume of air in the box is also set into vibration to produce a loud sound. Larger the surface area of the air in the sound box, louder will be the sound produced.

Solution 25
The intensity of a sound wave at any point of the medium is measured as the amount of sound energy passing per second normally through unit area at that point.Its unit is microwatt per **metre^2.**

Solution 26
Loudness of a sound (L) and its intensity (I) are related as:L = k log (I/Io),Here, I/Io is the intensity level of the sound or the ratio between its intensity I and the threshold intensity Io, and k is the constant of proportionality depending upon the unit chosen.

Solution 27
(a) If frequency of a musical sound is increased, its pitch will increase.
(b) If amplitude of a musical sound is increased, its loudness will also increase.

Solution 28
Loudness depends on the energy conveyed by the wave near the eardrum of a listener. Loudness being a sensation also depends upon the sensitivity of the ears of listener. Thus, loudness of a sound of given intensity may differ from listener to listener.Further, two sounds of the same intensity, but of different frequencies may differ in loudness even to the same listener because the sensitivity of the ears is different for different frequencies. Thus loudness is a subjective quantity, while intensity, being a measurable quantity, is an objective quantity for a sound wave.

Solution 29
The loudness of a sound heard by a listener depends upon:1. Loudness is directly proportional to the square of the amplitude.2. Loudness varies inversely as the square of distance.3. Loudness is directly proportional to the surface area of a vibrating body.

Solution 30
Unit used to measure sound level is decibel (dB).

Solution 31
Sound from two musical instruments of same pitch and same loudness can be distinguished by their different quality or timbre. The quality of a musical sound depends on the wave form and the wave form of an instrument depends on the presence of the subsidiary vibrations along with the principal vibrations and the relative amplitudes of the various subsidiary vibrations in relation to the principal vibration.

Solution 32

Quality of sound of the same pitch differs when produced by different instruments because of the difference in their waveforms. Different instrument emit different subsidiary notes due to the presence of mixture of subsidiary vibrations along with the principal vibration. The subsidiary vibrations present in the musical note make the wave form complex and thus we can easily distinguish between the sound so different instruments, though they may be of same pitch.

Solution 33

The number, and nature of harmonics and overtones present, affects the quality of sound. The different combinations of number and nature of harmonics and overtones present in the 'notes' gives these different wave patterns.