7	Sound	Book: Selina

Exercise A

1. **What are mechanical waves?**
   A mechanical wave is a wave that is not capable of transmitting it's energy through vacuum. They require a medium in order to transport their energy from one location to another. Example — Sound wave. The mechanical waves are of two types — (a) Longitudinal waves and (b) Transverse waves.
2. **Define the following terms in relation to a wave — (a) amplitude, (b) frequency, (c) wavelength and (d) wave velocity.**
   (a) Amplitude (a) — When sound waves travel in a medium, the maximum displacement of the particle of medium on either side of its mean position, is called amplitude of the wave.
   (b) Frequency (f) — The number of vibrations made by the particle of the medium in one second.
   (c) Wavelength (λ) — The distance travelled by a wave in one time period of vibration of the particle of the medium, is called the wavelength.
   (d) Wave velocity (V) — The distance travelled by the wave in one second.
3. **A wave passes from one medium to another medium. Mention the property of the wave (i) which changes, (ii) which does not change.**
   (i) Wavelength (or speed), (ii) frequency
4. **State two factors on which the speed of a wave travelling in a medium depends.**
   Density and elasticity
5. **State two differences between the light and sound waves.**

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

6. **What do you mean by reflection of sound? State one condition for the reflection of a sound wave. Name a device in which reflection of a sound wave is used.**
   The return of a sound wave on striking a surface such as a wall, metal sheet, plywood etc. back in the same medium is called reflection of the sound wave. The only requirement for the reflection of sound wave is that the size of the reflecting surface must be bigger than the wavelength of the sound wave. The phenomenon of reflection of sound wave is utilized in making the megaphone (or speaking tube).
7. **What is meant by an echo? State two conditions necessary for an echo to be heard distinctly.**

The sound heard after reflection from a distant obstacle (such as a cliff, a hillside, the wall of a building, edge of a forest, etc.) after the original sound has ceased, is called an echo.

The two conditions for an echo to be heard distinctly are —

(a) The minimum distance between source of sound (or observer) and reflector in air must be 17 m.

(b) The size of the reflector must be large enough as compared to the wavelength of the sound wave

8. A man is standing at a distance of 12 m from a cliff. Will he be able to hear a clear echo of his sound ? Give a reason for your answer.

As we know,

$$\text{Speed of sound (V)} = \frac{\text{Total distance travelled (2d)}}{\text{time interval (t)}}$$

Total distance travelled by the sound in going and then coming back = 2d

Given, d = 12 m, V = 340 ms-1

Substituting the values in the formula above, we get,

$$340 = \frac{2 \times 12}{t}$$

$$t = \frac{2 \times 12}{340}$$

t=0.07s

Hence, time = 0.07 s.

An important condition for hearing an echo is that the reflected sound should reach the ear only after a lapse of at least 0.1 s after the original sound dies off.

The time in this case is less than 0.1 s. Hence, the man will not hear the echo.

9. State two applications of echo.

(1) In sonar {sound navigation and ranging), ultrasonic waves are sent in all directions from the ship and they are then received on their return after reflection from an obstacle. If there is some obstacle such as an enemy submarine, iceberg, a sunken ship etc., its distance from the source can be calculated by measuring the time interval between the instant when waves are sent and the instant when waves are received after reflection from the obstacle.

(2) In medical science, the echo method of ultrasonic waves is used for imaging the human organs such as the liver, gallbladder, uterus, womb, etc. This is called ultrasonography. Similarly, echo cardiography is used to obtain the image of human heart.

10. Explain how the speed of sound can be determined by the method of echo.

The echo method can be used for determining the speed of sound in air. For this, sound is produced from a place at a known distance say, d at least 50 m from the reflecting surface. The time interval t in which the echo reaches the place from where the sound was produced, is noted by a stop watch having the least count 0.01 s. Then the speed of sound is calculated by using the following relation:

$$V = \frac{\text{Total distance travelled}}{\text{Time interval}}$$

$$V = \frac{2d}{t}\ ms^{-1}$$

11. State the use of echo by a bat, dolphin and fisherman.

(1) Bats can produce and detect the sound of very high frequency up to about 100 kHz. The bats fly with speed much lower than the speed of sound. The sounds produced by the flying bats get reflected back from an obstacle in front of it. By hearing the echoes, bats come to know even in the dark where the obstacles are. So they can fly safely without colliding with the obstacles. This process of detecting obstacles is called sound ranging.

(2) Dolphins detect their enemy and obstacles by emitting the ultrasonic waves and hearing their echo. They use ultrasonic waves for hunting their prey.

(3) A trawler man or fisherman sends a pulse of ultrasonic waves from a source (a very high frequency vibrator) into the sea and receives in the detector the waves reflected from the shoal offish. The total time t of the to and fro journey of the wave is recorded. The position of fish is then calculated by using the relation d = Vt/2 where V is nearly 1400 m s^{-1} (speed of ultrasonic waves in sea water).

12. How do bats avoid obstacles in their way, when in flight?

The bats fly with speed much lower than the speed of sound. The sounds produced by the flying bats get reflected back from an obstacle in front of it. By hearing the echoes, bats come to know even in the dark where the obstacles are. So they can fly safely without colliding with the obstacles.

13. What is meant by sound ranging? Give one use of sound ranging.

The process in which produced sound get reflected back from an obstacle in front of it is called sound ranging. Dolphins detect their enemy and obstacles by this process.

14. Name the waves used for sound ranging. Why are waves mentioned by you, not audible to us?

Ultrasonic waves are used for the sound ranging. It is not audible because the ultrasonic waves has frequency above 20,000 Hz and audible sound waves frequency is between 20 Hz to 20,000 Hz.

15. What is sonar? State the principle on which it is based.

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 the 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, where v is the velocity of the ultrasonic wave.

16. State the use of echo in medical science.

In medical science, the echo method of ultrasonic waves is used for imaging the human organs such as the liver, gallbladder, uterus, womb, etc. This is called ultrasonography. Similarly, echo cardiography is used to obtain the image of human heart.

17. Name waves which are used in sonar to find the depth of a sea. Give one reason for their use.

Sonar use ultrasonic waves to find the depth of a sea. The reason is that the ultrasonic waves (frequency above 20,000 Hz) travel undeviated through long distances and they can be confined to a narrow beam. They are not easily absorbed in a medium.

18. MULTIPLE CHOICE TYPE:

(1) The minimum distance between the source and the reflector in air, so that an echo is heard, is approximately equal to : 17 m.

(2) Bats detect the obstacles in their path by receiving the reflected: ultrasonic waves.

Exercise B

1. What do you understand by the natural vibrations of a body? Give one example.

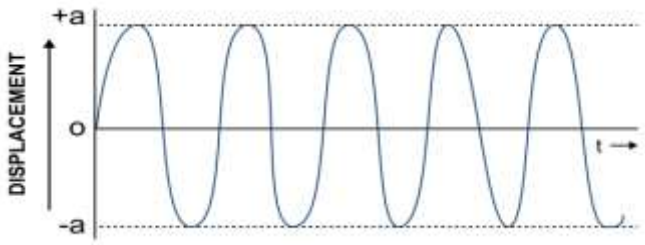
The periodic vibrations of a body in the absence of any external force on it, are called the natural (or free) vibrations. For example — A body clamped at one point when disturbed slightly from its rest position, starts vibrating. The vibrations so produced are called the natural or free vibrations of body.

2. What is meant by natural frequency of vibrations of body? Name one factor on which depends?

The natural frequency is the frequency at which a body tends to oscillate in the absence of any driving or damping force. The natural frequency of vibrations of a body depends on the shape and size (or structure) of the body.

3. Answer the following:

(a) Draw a graph between displacement and time for a body executing natural vibrations.



(b) Where can a body execute the natural vibrations?

The natural vibrations can occur only in vacuum. However, in practice it is very difficult to have vacuum. Hence, it is very difficult to realise such vibrations in real life.

4. State one condition for a body to execute free vibrations.

The free vibrations of a constant amplitude can execute only in vacuum.

5. Answer the following:

(a) Name one factor on which the frequency of sound emitted due to vibrations in an air column depends.

It depends on the length of air column.

(b) How does the frequency depend on the factor stated in part (a)?

As we know, Frequency (f) = $^1/_l$ Hence, frequency is inversely proportional to length, so in order to increase the frequency, the length has to be decreased.

6. State one way of increasing the frequency of a note produced by an air column.

The frequency of the note can be increased (a) by decreasing the length *l* of the string, (b) by decreasing the radius *r* (or thickness) of the string, and(c) by increasing the tension T in the string.

7. State two ways of increasing the frequency of vibrations of a stretched string.

Ans, (a) by increasing the tension in the string (b) by decreasing the length of the string.

How does the frequency of sound given by a stretched string depend on its (a) length, (b) tension?

8. How does frequency of sound given by a stretched string depend on its (a) length, (b) tension?

(a) As we know,

$$\text{frequency (f)} = \frac{1}{2l}\sqrt{\frac{T}{\pi r^2 d}}$$

Hence, the frequency of sound given by a stretched string is inversely proportional to the length of the string.

(b) The frequency of sound given by a stretched string is directly proportional to the square root of the tension in the string.

$$f \propto \sqrt{T}$$

9. What adjustments would you make for tuning a stringed instrument for it to emit a note of a desired frequency?

As we know,

$$\text{frequency (f)} = \frac{1}{2l}\sqrt{\frac{T}{\pi r^2 d}}$$

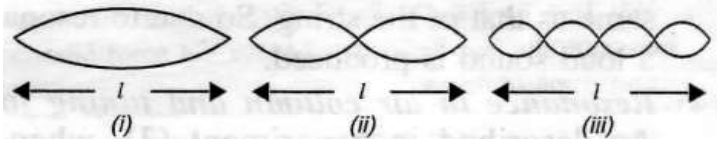
Hence, frequency of a desired note can be obtained by altering the following —

(a) Length of the string — In order to increase the frequency, the length of the string should be decreased.

(b) Radius (thickness) of the string — In order to increase the frequency, the radius of the string should be decreased.

(c) Tension in the string — In order to increase the frequency, the tension in the string should be increased.

10. The diagram below in Fig. shows three ways in which the string of an instrument can vibrate.



(a) Which of the diagram shows the principal note?

First

(b) Which has the frequency four times that of the first?

Third

(c) Which vibration is of longest wavelength ?

The vibration in part (i) has the longest wavelength.

(d) What is the ratio of the frequency of the vibration in (i) and (ii)?

1 : 2

11. Explain why strings of different thicknesses are provided on a stringed instrument.

Natural frequency of vibration of a stretched string is inversely proportional to the radius (or thickness) of string and so this is done so as to produce sound of desired frequency. When we pluck the string of greater thickness, the frequency of sound produced decreases.

12. A blade, fixed at one end, is made to vibrate by pressing its other end and then releasing it. State one way in which the frequency of vibrations of the blade can be lowered.

Ans. By increasing the length of the blade or by sticking a small weight on the blade at its free end.

13. How does the medium affect the amplitude of free vibrations of a body?

The amplitude of a freely vibrating body should remain constant. Once a body starts vibrating, it should continue with the same amplitude forever. In practice, this does not happen in medium as it offers resistance (or friction) to the motion. The vibrations of constant amplitude can occur only in vacuum. So, there is no effect of medium on it as it is absent.

14. What are damped vibrations? How do they differ from free vibrations? Give two examples.

The periodic vibrations of a body of decreasing amplitude in presence of a resistive force are called the damped vibration.

In the case of damped vibrations, the amplitude of vibrations gradually decreases with time and ultimately it ceases whereas in the case of free vibrations the amplitude of vibrations remains constant and it continues forever.

Example of damped vibration — A tuning fork when stroked on rubber pad, executes damped vibrations in air.

Example of free vibration — The vibrations of a constant amplitude can only occur in vacuum. Since, in practice, it is very difficult to have vacuum. Hence, it is very difficult to realise such vibrations in practice.

15. The diagram in Fig. 7.12 shows the displacement- time graph of a vibrating body.

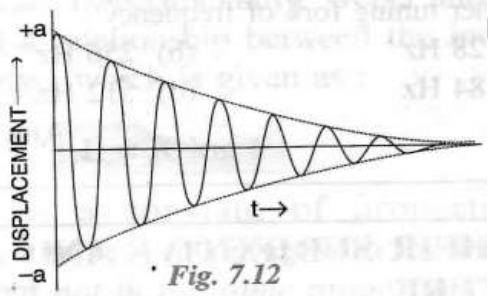


Fig. 7.12

(1) Name the kind of vibrations.

Damped vibration

(2) Give one example of such vibrations,

A tuning fork vibrating in air

(3) Why is the amplitude of vibrations gradually decreasing?

The amplitude of motion decreases due to the factional (or resistive) force which the surrounding medium exerts on the body vibrating in it

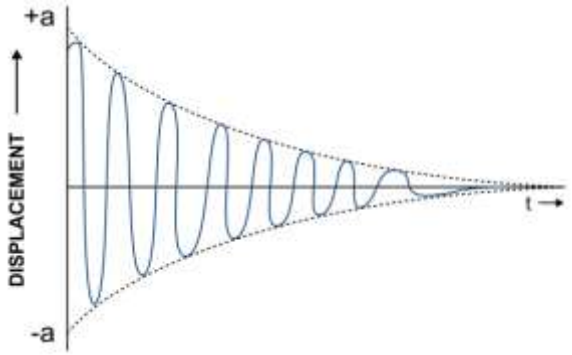
(4) What happens to the vibrations of the body after some time?

After some time, when it has lost all its energy, it stops vibrating.

16. A tuning fork is vibrating in air. State whether the vibrations are natural or damped.

A tuning fork when stroked on a rubber pad, executes damped vibrations in air.

17. Draw a sketch showing the displacement against time for a body executing the damped vibrations.



18. What are forced vibrations? Give one example to illustrate your answer.

The vibrations of a body which take place under the influence of an external periodic force acting on it, are called the forced vibrations. For example, 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 the forced vibrations. Since the table top has a much larger vibrating area than the tuning fork, the forced vibrations of the table top produce a louder (or more intense) sound than that produced by the tuning fork

19. On keeping the stem of a vibrating tuning fork on the surface of a table, a loud sound is heard. Give reason.

When the stem of a vibrating tuning fork is pressed against the top of a table, the forced vibrations are produced on the surface of table.

The table top has a much larger vibrating area than the tuning fork, so the forced vibrations of the table top send forth a greater energy and hence, produce a larger sound (or more intense) than that produced by the fork.

20. State two differences between natural and forced vibrations.

Natural Vibrations	Forced Vibrations
The vibrations of a body in absence of any resistive or external force are called natural vibrations.	The vibrations of a body in a medium in presence of an external periodic force are called forced vibrations.
The frequency of vibrations remains constant.	The frequency of vibration changes with change in the frequency of the applied force.

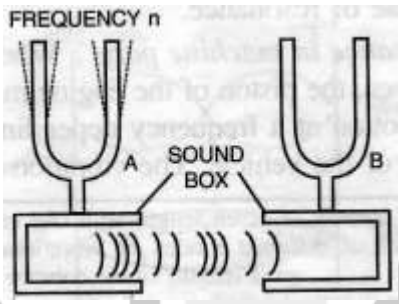
21. What is meant by resonance? Describe a simple experiment to illustrate the phenomenon of resonance and explain it.

Resonance is a special case of the forced vibrations. When the frequency of an externally applied periodic force on a body is equal to its natural frequency, the body readily begins to vibrate with an increased amplitude. This phenomenon is known as resonance. The vibrations of large amplitude are called resonant vibrations.

The phenomenon of resonance can be demonstrated by the following experiments.

Experiment (1)-Resonance with tuning forks :

Mount two identical tuning forks A and B of the same frequency upon two separate sound boxes such that their open ends face each other as shown in Fig. 7.7. If the prong of one of the tuning forks say, A is struck on a rubber pad, it starts vibrating. On putting the tuning fork A on its sound box, we find that the other tuning fork B also starts vibrating and a loud sound is heard. The vibrations produced in the second tuning fork B are the forced vibrations and the sound is loud due to resonance



Reason- 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 air in the sound box. 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 the same as the natural frequency of the fork B, the fork B picks up these vibrations and starts vibrating under resonance. Thus the two sound boxes help in communicating the two vibrations and in increasing the amplitude of vibrations

22. State the condition for the occurrence of resonance.

Resonance occurs when the frequency of the applied force is exactly equal to the natural frequency of the vibrating body.

23. Complete the following sentence :

Resonance is a special case of _____ vibrations, when frequency of the driving force is _____ natural frequency of the body. *(forced, equal to the)*

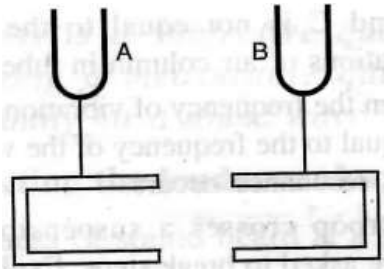
24. Differentiate between the forced and resonant vibrations.

Forced vibrations	Resonant vibrations
The vibrations of a body under an external periodic force of frequency different from the natural frequency of the body, are called Forced vibrations.	The vibrations of a body under an external periodic force of frequency exactly equal to the natural frequency of the body are called Resonant vibrations.
The amplitude of vibration is small.	The amplitude of vibration is very large.

25. Why is a loud sound heard at resonance?

At resonance, the body vibrates with large amplitude thus conveying more energy to the ears, so a loud sound is heard.

26. Figure shows two tuning forks A and B of the same frequency mounted on separate sound boxes with their open ends facing each other. The fork A is set into vibration,



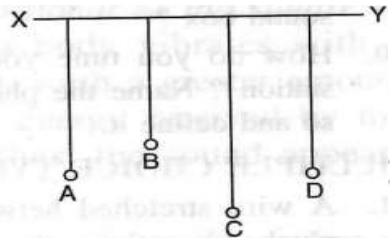
(a) Describe your observation,

If the prong of tuning fork A is struck on a rubber pad, it starts vibrating. On putting the tuning fork A on its sound box, we find that the other tuning fork B also starts vibrating and a loud sound is heard.

(b) State the principle illustrated by this experiment.

The vibrations produced in the second tuning fork B are the forced vibrations and the sound is loud due to resonance.

27. In Fig. 7.14, A, B, C and D are four pendulums suspended from the same elastic string XY. Lengths of pendulum A and D are equal, while the length of pendulum B is smaller and the pendulum C is longer. The pendulum A is set into vibration,



(a) What is your observation?

When pendulum A is set into vibration, it is observed that the pendulum D also starts vibrating initially with a small amplitude and ultimately it acquires the same amplitude as the pendulum A initially had.

(b) Give reason for your observation.

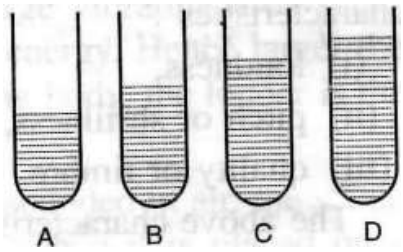
When the amplitude of vibrations of pendulum D becomes maximum, the amplitude of pendulum A becomes minimum since total energy is constant. After sometime, the amplitude of pendulum D decreases and that of A increases. Note that the exchange of energy takes place only between the pendulums A and D because their natural frequencies are equal. However, the vibrations of pendulum D are in phase with those of A (i.e., they reach their extreme positions on either side simultaneously). The pendulums B and C also vibrate, but each of them vibrate with a very small amplitude.

28. A vibrating tuning fork, held over an air column of a given length with its one end closed, produces a loud audible sound. Name the phenomenon responsible for it and explain the observation.

The phenomenon responsible for producing a loud audible sound when a vibrating tuning fork, held over an air column of a given length with its one end closed is known as resonance.

The frequency of air column becomes equal to the frequency of the tuning fork vibrating over its mouth, a loud sound is heard due to resonance.

29. In Fig. 7.15, A, B,C and D represent test tubes each of height 20 cm which are filled with water up to heights of 12cm, 14cm, 16cm and 18 cm respectively. If a vibrating tuning fork is placed over the mouth of test tube D, a loud sound is heard.



(a) Describe the observations with the tubes A, B and C when the vibrating tuning fork is placed: over the mouth of these tubes.

No loud sound is heard with the tubes A and C, but a loud sound is heard with the tube B.

(b) Give the reason for your observation in each case.

Resonance occurs with the air column in tube B whereas no resonance occurs in air column of tubes A and C. The frequency of vibrations of air column in tube B is same as the frequency of vibrations of air column in tube D because the length of air column in tube D is 20 – 18 = 2 cm and that in tube B is 20 – 14 = 6 cm (i.e., three times). On the other hand, the frequency of vibrations of air column in tubes and C is not equal to the frequency of vibrations of air column in tube B.

(c) State the principle illustrated by the above experiment.

When the frequency of vibrations of air column is equal to the frequency of the vibrating tuning fork, resonance occurs.

30. When a troop crosses a suspension bridge, the soldiers are asked to break steps. Explain the reason.

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

31. Why are the stringed instruments provided with a sound box?

A vibrating string by itself produces a very weak sound which cannot be heard at a distance. Therefore all musical stringed instruments such as guitar and sonometer are provided with a sound box (i.e. a hollow chamber). The box is so constructed that the column of air inside it, has a natural frequency which is 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 into forced vibrations. Since the sound box has a large area, it sets a large volume of air into vibration, the frequency of which is same as that of the string. So due to resonance, a loud sound is produced

32. How do you tune your radio set to a particular station? Name the phenomenon involved in doing so and define it.

The radio has electronic circuits which produce electrical vibrations, the frequency of which can be changed by changing the values of the electronic components of that circuit. When we want to tune a radio receiver, we merely adjust the values of the electronic components to produce vibrations of frequency equal to that of the radio waves which we want to receive. When the two frequencies match, due to resonance, the energy of signal of that particular frequency is received from the incoming waves. The signals of other frequencies from the incoming waves do not transfer their energy to the receiver circuit. The signal received is then amplified in the receiver set. The phenomenon involved in doing so is resonance. It is a special case of the forced vibrations. When the frequency of an externally applied periodic force on a body is equal to its natural frequency, the body readily begins to vibrate with an increased amplitude. This phenomenon is known as resonance.

33. Multiple Choice:

(1) A wire stretched between two fixed supports, is plucked exactly in the middle and then released. It executes (neglect the resistance of the medium): free vibrations.

(2) When a body vibrates under a periodic force. The vibrations of the body are forced vibration.

(3) A tuning fork of frequency 256 Hz will resonate with another tuning fork of frequency: 256 Hz.

Exercise C

1. Name three characteristics of a musical sound.

Three characteristics of a musical sound are

(1) loudness,

(2) pitch or shrillness, and

(3) quality or timbre

2. (a) Which of the following quantity determines the loudness of a sound wave?

(i) wavelength. (ii) frequency, and (iii) amplitude.

(iii) amplitude

(b) How is loudness related to the quantity mentioned above in part (a)?

Loudness α (amplitude)^2

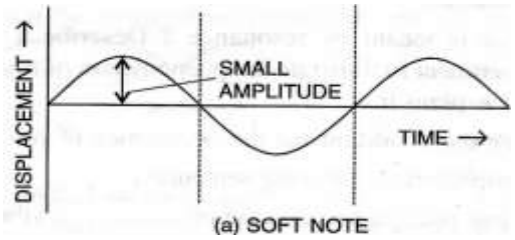
3. If the amplitude of a wave is doubled, what will be the effect on its loudness?

Loudness will increase (become four times)

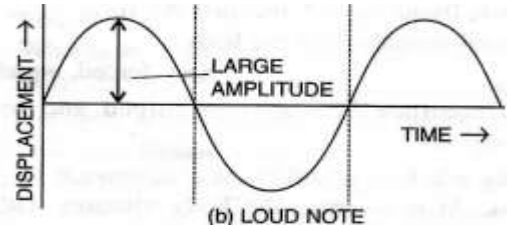
4. **Two waves of the same pitch have amplitudes in the ratio 1 : 3. What will be the ratio of their(i) loudness (ii) frequencies?**

   (i) 1 : 9 (ii) 1 : 1 .

5. **How does the wave pattern of a loud note differ from a soft note? Draw a diagram.**



(a) SOFT NOTE



(b) LOUD NOTE

   The two waves have the same frequency and same wave form (sine wave), but they differ in amplitude. Obviously, the louder sound corresponds to the wave of larger amplitude.

6. **Name the unit in which loudness of sound is measured.**

   phon

7. **Why is the loudness of the sound heard by a plucked wire increased when it is mounted on a sound board?**

   Loudness depends on the surface area of the vibrating body. A large vibrating area sends forth a greater amount of energy. When wire is mounted on a sound board, it provides comparatively a large area and forces a large volume of air to vibrate and thereby increases the sound energy reaching our ears.

8. **Define the term intensity of a sound wave. State the unit in which it is measured.**

   Intensity of sound at any point in space is defined as the amount of sound energy passing per unit time per unit area around that point in a direction perpendicular to the area. The intensity of sound is measured in bel or decibel.

9. **How is loudness of sound related to the intensity of wave producing it?**

   The loudness L is related to the intensity I as $L = K \log_{10} I$.

10. **Comment on the statement 'loudness of sound is a subjective quantity, while intensity is an objective quantity.'**

    The loudness of a sound depends on the energy conveyed by the sound wave near the eardrum of the listener. Loudness being a sensation, also depends upon the sensitivity of the ears of the listener. Thus the loudness of sound of a given intensity may differ from listener to listener {i.e., the sound of the same intensity may appear to be of different loudness to different persons). 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. For normal ears, the sensitivity is maximum at frequency 1 kHz. Thus loudness is a subjective quantity, while intensity, being a measurable quantity, is an objective quantity for a sound wave.

11. **State three factors on which loudness of sound heard by a listener depends**

(1) Loudness is proportional to the square of the amplitude – When a body vibrates with a greater amplitude, it sends forth a greater amount of energy and hence the energy received by the eardrum is also large. Thus, the sound appears louder.

(2) Loudness varies inversely as the square of the distance – If the listner is close to the source of sound, he will hear it quite louder, but if he is far away, the sound will become feeble. If he moves further away from the source, a stage may reach when the sound becomes inaudible. Thus, closer the source, the louder is the sound.

(3) Loudness depends on the surface area of the vibrating body – A large vibrating area sends forth a greater amount of energy. Hence larger the surface area of the vibrating body, the louder is the sound heard.

12. The bells of a temple are big in size. Why?

As a large vibrating area sends forth a greater amount of energy. Hence, larger the surface area of the vibrating body, louder is the sound heard. Therefore, the bells of a temple are made big in size so that a louder sound is heard

13. Name the unit used to measure the sound level.

decibel

14. What is the safe limit of sound level in dB for our ears?

Upto 120 dB

15. What is meant by noise pollution? Name one source of sound causing noise pollution.

The disturbance produced in the environment due to undesirable loud and harsh sound of level above 120 dB, from the various sources is called noise pollution. Examples are loudspeaker, siren, moving vehicles etc.

16. What determines the pitch of a sound?

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.

17. Name the subjective property of sound related to its frequency.

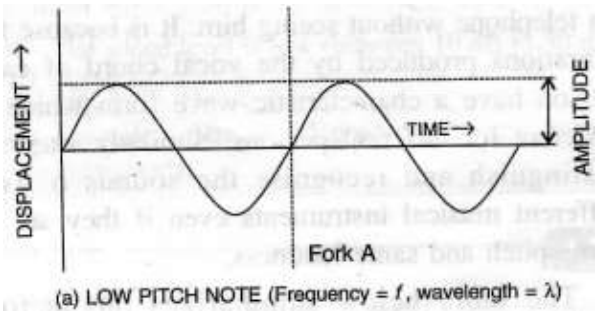
pitch

18. Name and define the characteristic which enables one to distinguish two sounds of same loudness, but of different frequencies, given by the same instrument.

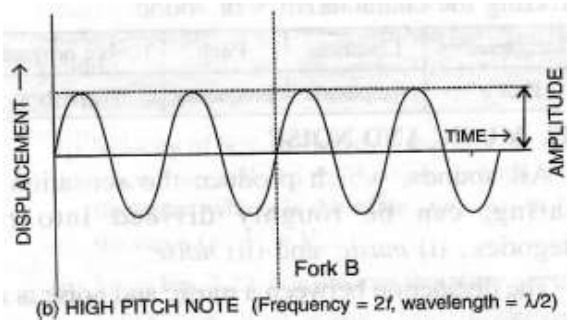
Pitch is that characteristic of sound by which an acute (or shrill) note can be distinguished from a grave or flat note.

Two notes of the same amplitude and sounded on the same instrument will differ in pitch when their vibrations are of different wavelengths (or of different frequencies).

19. Draw a diagram to show the wave pattern of high pitch note and a low pitch note, but of the same loudness.



(a) LOW PITCH NOTE (Frequency = f, wavelength = λ)



(b) HIGH PITCH NOTE (Frequency = $2f$, wavelength = $\lambda/2$)

20. How is it possible to detect the filling of a bottle under a water tap by hearing the sound at a distance?

As the water level in a bottle kept under a water tap rises, the length of air column decreases, so the frequency of sound produced increases i.e., the sound becomes shriller and shriller. Thus by hearing the sound from a distance, one can get the idea of water level in the pitcher.

21. The frequencies of notes given by flute, guitar and trumpet are respectively 400 Hz, 200 Hz and 500 Hz. Which one of these has the highest pitch?

Trumpet

22. Complete the following sentences :

(a) The pitch of sound increases if its frequency _____. *(increases)*

(b) If the amplitude of a sound is halved, its loudness becomes _____. *(one-fourth)*

23. The diagram below shows three different modes of vibration P, Q and R of the same string of a given length.

(a) Which vibration will produce a louder sound and why?

The vibration which produces loudest sound is R, because it's amplitude is maximum.

(b) Which vibration will produce sound of maximum shrillness (or pitch) and why?

The vibration which produces maximum shrillness (or pitch) is P, because it's frequency is maximum.

(c) What is the ratio of the wavelength of vibrations P and R?

Let l be the length of the string.

Wavelength of P (λ_P) = $\frac{2l}{3}$

Wavelength of R (λ_R) = 2l

Therefore, ratio of $\lambda_P : \lambda_R$ =

$= \frac{2l}{3 \times 2l}$

$= \frac{1}{3}$

Hence,

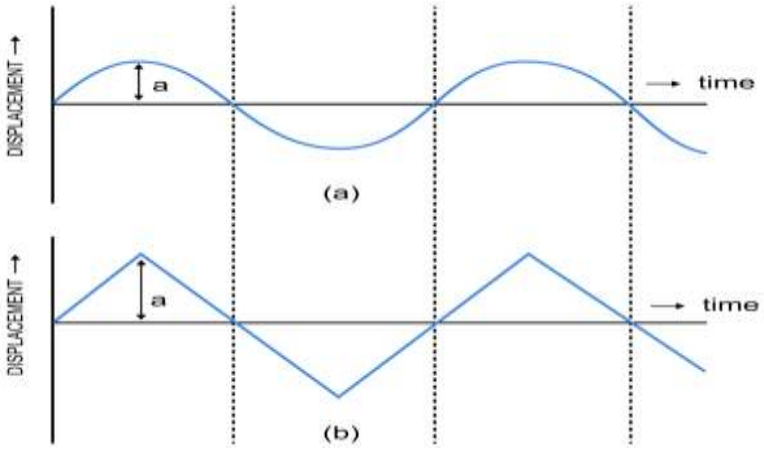
$\lambda_P : \lambda_R = 1 : 3$

24. Name the characteristic which enables one to distinguish the sound of two musical instruments even if they are of the same pitch and same loudness.

Ans. quality

25. How does the two sounds of the same loudness and same pitch produced by different instruments differ? Draw diagrams to illustrate your answer.

Quality (or timbre) of a sound is characteristic which distinguishes the two sounds of same loudness and same pitch, but emitted by two different instruments because of change in their wave form.



The figure above shows the wave forms of two sounds of same loudness (i.e., same amplitude) and same pitch (i.e., same frequency), but emitted by two different sources.

They produce different sensation in our ears because they differ in wave form, one is a sine wave while other is a triangular wave.

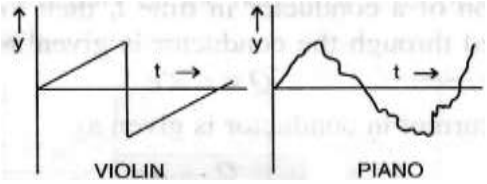
26. Two identical guitars are played by two persons to give notes of the same loudness and pitch. Will they differ in quality? Give a reason for your answer.

When two identical guitars are played by two persons to give notes of the same loudness and pitch then they will not differ in quality as the identical guitars will produce identical wave forms.

Quality of a musical instrument depends on the number of subsidiary notes and their relative amplitudes present in it along with the principal note.

As same instruments produce same principal and subsidiary notes. Hence, the quality of identical guitars will be same.

27. Two musical notes of the same pitch and same loudness are played on two different instruments. Their wave patterns are as shown in Figure.



Explain why the wave patterns are different.

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

28. Which characteristic of sound makes it possible to recognize a person by his voice without seeing him?

We generally recognize a person by his voice without seeing him because the vibrations produced by the vocal chord of each person have a characteristic wave form which is different for different persons.

29. State the factors that determine

(1) the pitch of a note, *(frequency)*

(2) the loudness of the sound heard, *(amplitude)*

(3) the quality of the note. *(wave form)*

30. Name the characteristic of the sound affected due to a change in its (i) amplitude (ii) wave form (iii) frequency.

(i) loudness (ii) quality (iii) pitch.

31. The sketches I to IV in Figure show sound waves, all formed in the same time interval.

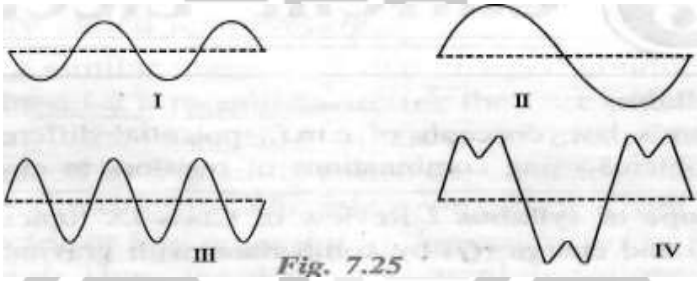


Fig. 7.25

Which diagram shows

(1) a note from a musical instrument,

Note from a musical instrument is shown by figure IV as the sketch has subsidiary notes and all musical instruments produce subsidiary notes.

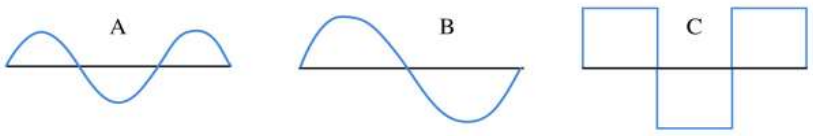
(2) a soft (not loud) note,

Soft (or feeble) note is shown by figure I, as we can observe from the wave form that it has the lowest amplitude.

(3) a bass (low frequency) note.

Bass (or low frequency) note is shown by Figure II, as we can observe from the wave form that it has the lowest frequency.

32. Figure below shows the wave patterns of three sounds A, B and C. Name the characteristic of sound which is same between (i) A and B, (ii) B and C, and (iii) C and A.



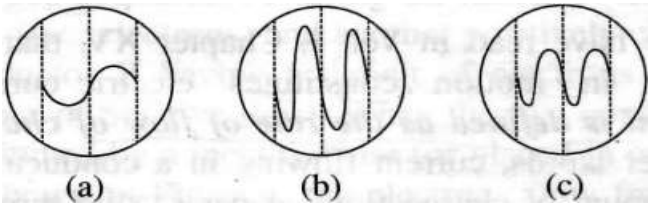
Answer

(i) When we observe the figure shown, we find that both A and B have same amplitude and wave form. Hence, the characteristics of sound which are same in both A and B are loudness and quality.

(ii) When we observe the figure shown, we find that in B and C, none of the characteristics are same.

(iii) When we observe the figure shown, we find that in both C and A, frequency is same. Hence, pitch is same.

33. A microphone is connected to the Y-input of a C.R.O. Three different sounds are made in turn in front of the microphone. Their traces (a), (b) and (c) produced on the screen are shown in Figure.



(i) Which trace is due to the loudest sound? Give reason for your answer.

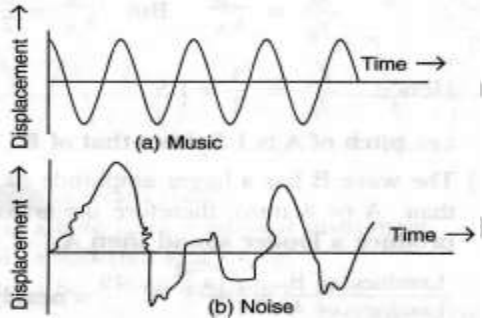
Figure – (b), since amplitude is largest

(ii) Which trace is due for the sound with the lowest pitch? Explain your answer.

Figure – (a), since frequency is lowest.

34. In what respect does the wave pattern of a noise and a music differ? Draw diagram to explain your answer.

In wave pattern of music, all the component waves are similar without any sudden change in their wavelength and amplitude. In noise, the component waves change their character suddenly and they are of short duration.



35. Differentiate between a musical note and a noise.

Music	Noise
1. It is pleasant, smooth and acceptable to the ear.	1. It is harsh, discordant and non-acceptable to the ear.
2. It is produced by the vibrations which are periodic.	2. It is produced by an irregular succession of disturbances.
3. All the component waves are similar without any sudden change in their wavelength and amplitude.	3. The component waves change their character suddenly and they are of short duration.
4. The sound level is low (between 10 dB to 30 dB).	4. The sound level is high (above 120 dB).
5. The wave form is regular	5. The wave form is irregular
6. *Example :* The sound produced by the musical instruments.	6. *Example :* The sound produced by an aeroplane, road roller, etc.

36. MULTIPLE CHOICE TYPE

(1) By reducing the amplitude of a sound wave, its loudness decreases.

(2) Two sounds of same loudness and same pitch produced by two different instruments differ in their wave forms.

(3) Two sounds A and B are of frequencies f and $2f$ respectively. Then: B is shrill, A is grave.