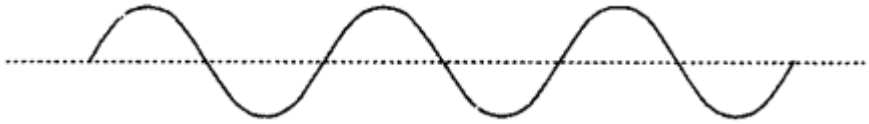
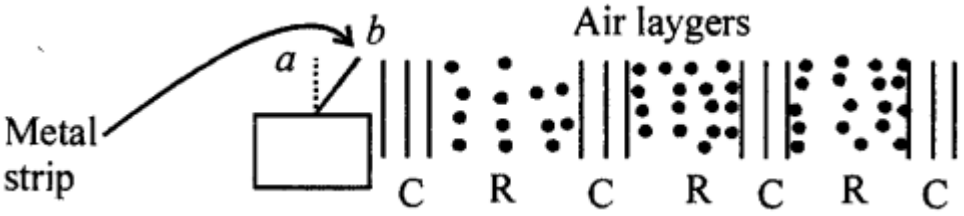
7. Sound

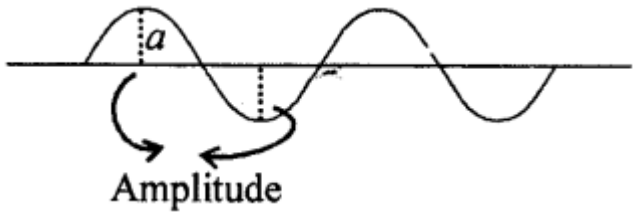
- SOUND: “Is energy which produces in us the sensation of hearing.” It is produced by vibration of body.
- Sound needs a medium for its propagation. Sound cannot travel in vacuum.
- Speed of sound is maximum in solids. 5000 ms^{-1} in steel, in water 1500 ms^{-1} and in air it is least 330 ms^{-1} nearly.
- When a body vibrates, the particles of medium also start vibrating and K.E. of particles changes into potential energy and P.E. into K.E. This is why sound in energy.
- Sound travels in a medium in the form of wave.



- Longitudinal wave : When the particles of medium move in the direction of motion of wave by forming compression and rarefaction.

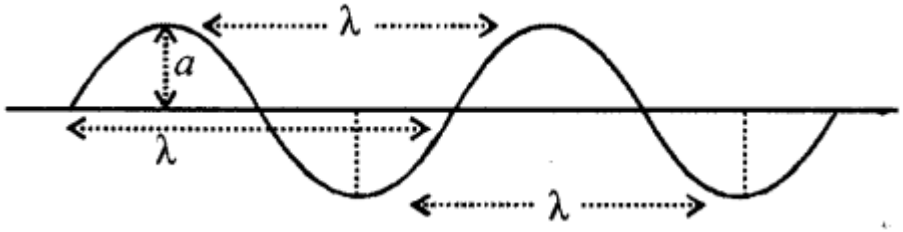


- AMPLITUDE : “The maximum displacement of the particle of medium on either side of mean position.”



- TIME PERIOD: “The time taken by a particle of medium to complete its one vibration” “t”
- FREQUENCY: “The number of vibrations made by a particle of the medium in one second. f measured in Hertz (Hz)
- FREQUENCY $f = 1/t$ or $t = 1/f$
- WAVE LENGTH: “The distance travelled by the wave in one one time period of vibration of particle of medium.”
  Or
  “The distance between two consecutive compressions or between two consecutive rarefactions.” It is denoted by ‘ λ ’ and S.I. unit of wave length is metre

(m).



- CHARACTERISTICS OF SOUND :
  (i) Loudness.
  (ii) Pitch (or shrillness).
  (iii) Quality (or timbre or wave form).
  LOUDNESS : is the characteristic of sound by virtue of which a loud sound can be distinguished from a faint sound, both having same frequency and same wave form.
- It depend on: (i) Amplitude of wave (ii) Surface area of vibrating body (ii) Distance from the source of sound (iv) Sensitivity of listener: Unit of loudness is (dB) decibel.
- PITCH: It depends on number of vibrations per second or frequency : more frequency is high pitch shrilled sound and low frequency is flat sound.
- QUALITY: is the characteristic which distinguishes two sounds'of the same pitch and same loudness. It depends on wave form.

Test yourself

A. Objective Questions

1. Write true or false for each statement

(a) When sound propagates in air, it does not carry energy with it.
Answer. False.

(b) In a longitudinal wave, compression and rarefaction are formed.
Answer. True.

(c) The distance from one compression to nearest rarefaction is called wavelength.
Answer. False.

(d) The frequency is measured in second.
Answer. False.

(e) The quality of a sound depends on the amplitude of wave.
Answer. False.

(f) The pitch of sound depends on frequency.
Answer. True.

(g) Decibel is the unit of pitch of a sound.
Answer. False.

2. Fill in the blanks

(a) The time period of a wave is 2 s. Its frequency is **0.5 S^{-1}.**
(b) The pitch of a stringed instrument is increased by **increasing** tension in string.
(c) The pitch of a flute is decreased by **increasing** length of air column.
(d) Smaller the membrane, **higher** is the pitch.
(e) If a drum is beaten hard, its loudness **increases.**
(f) A tuning fork produces sound of **single** frequency.

3. Match the following

	(a) Amplitude	**(i) frequency**
	(b) Frequency	**(ii) amplitude**
	(c) Loudness	**(iii) maximum displacement on either side**
	(d) Pitch	**(iv) presence of other frequencies**
	(e) Wave form	**(v) 1/time period**
Ans.	**Column A**	**Column B**
	(a) Amplitude	(iii) maximum displacement on either side
	(b) Frequency	(v) 1/time period
	(c) Loudness	(ii) amplitude
	(d) Pitch	(i) frequency
	(e) Wave form	(iv) presence of other frequencies

4. Select the correct alternative

(a) Sound can not travel in

1. solid
2. liquid
3. gas
4. **vacuum**

(b) When sound travels in form of a wave

1. the particles of medium move from the source to the listener
2. the particles of medium remains stationary
3. the particles of medium start vibrating up and down
4. **the particles of medium transfer energy without leaving their mean positions.**

(c) The safe limit of loudness of audible sound is

1. **0 to 80 dB**
2. above 80 dB
3. 120 dB
4. above 120 dB

(d) The unit of loudness is

1. **cm**
2. second
3. hertz
4. decibel

(e) In a piano, pitch is decreased by

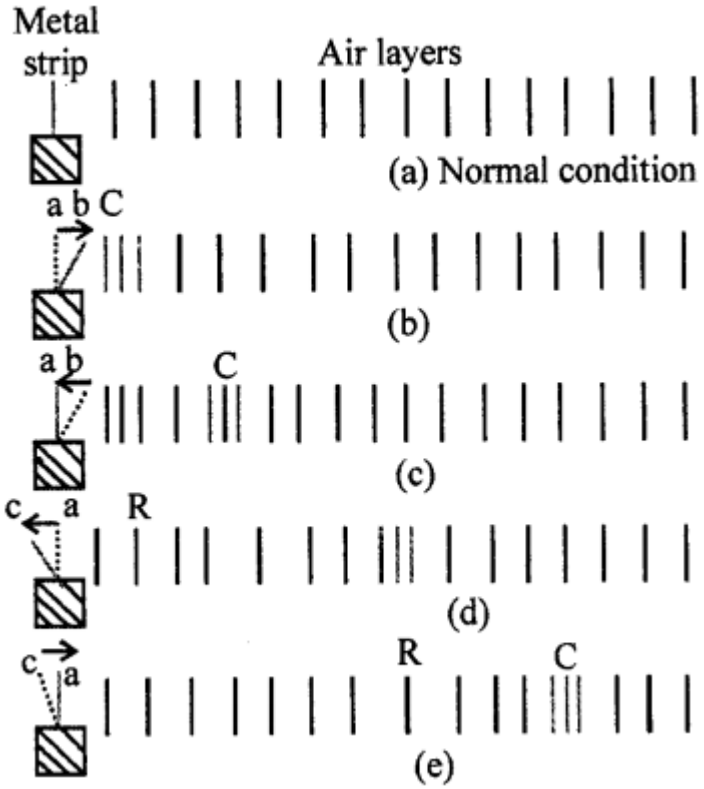
1. **using thicker string**
2. increasing tension
3. reducing length of string
4. striking it hard Ans.

B. Short/Long Answer Questions

Question 1.
How does sound travel in air ?
Answer:
A periodic disturbance in the medium (Air) is created by the vibration of sound and the particles of the medium vibrate about their mean position and transfer of energy in the form of sound waves takes place, i.e. in the LONGITUDINAL WAVES.

Question 2.
What is longitudinal wave ?
Answer:
Longitudinal wave: The wave in which the particles of the medium vibrate about their mean positions in the direction of propagation of sound is called longitudinal wave. Such a wave can be produced in solids, liquids as well as gases.

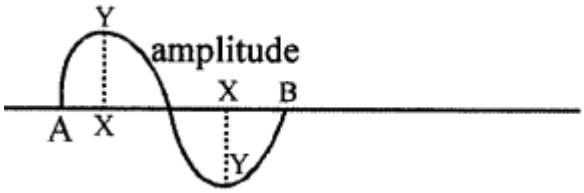
Question 3.
Explain the mechanism of formation of a longitudinal wave when source vibrates in air.
Answer:
PROPAGATION OF SOUND IN AIR : When a source of sound vibrates, it creates a periodic disturbance in the medium near it (i.e., the condition of medium changes). The disturbance then travels in the medium in form of waves. This can be understood by the following example.
Example: Take a vertical metal strip with its lower end fixed. Push its upper end to one side and then release it. As it vibrates, i.e. moves alternately to the right and left, sound is produced. Figure shows the steady (or mean position) of the metal strip and normal condition of air layers near the strip.



As the strip moves to the right from a to b in Figure it pushes the particles of air layer in front of it. So the particles of air in this layer come closer to each other i. e., air in that layer gets compressed (or compression is formed at C). The particles of this layer while moving towards right, pushes and compresses the layer next to it, which then compresses the next layer and so on. Thus the disturbance moves forward in form of

compression. The particles of the medium do not move with the compression.
As the metal strip starts returning from b to a in Figure after pushing the particles near the strip, the compression C moves forward and the particles of air near the strip return back to their normal positions due to the elasticity of the medium.
When the strip moves to the left from a to c in Figure it pulls the layer of air near it towards left and thus produces a space of very low pressure on its right side. The air layers on the right side of the strip expands in this region thus forming the rarefied layers. 'This region of low pressure is called a rarefaction R.
By the time the strip returns from c to its mean position a in Figure the rarefaction R moves forward and air layers near the strip return back to their normal position due to the elasticity of the medium.
In this manner, as strip moves to the right and left repeatedly, the compression and rarefaction regions are produced one after the other which carry the disturbance along it with, definite speed depending on the nature of the medium.
One complete to and fro motion of the strip forms one compression and one rarefaction which together constitute one wave. This wave in which the particles of the medium vibrate about their mean positions, in the direction of propagation of sound, is called the longitudinal wave. Thus sound travels in air form of longitudinal waves. Actually the longitudinal waves can be produced in solids, in liquids as well as in gases.
Thus, due to propagation of wave in a medium, the particles of the medium vibrate about their mean positions (without leaving their positions) and they transfer the energy with a constant speed from one place of medium to the other place.

Question 4.
Define the following terms :
(a) Amplitude
(b) Frequency
(c) Time period.
Answer:
(a)Amplitude (A) : The maximum displacement of a wave on either side of its mean position is called Amplitude A = XY = is amplitude.
(b) Frequency (f) or n
Number of oscillations made by a wave in one second is known as its frequency.
(c) Time Period (T): Time taken to complete one vibration is called Time Period, i.e. from A to B



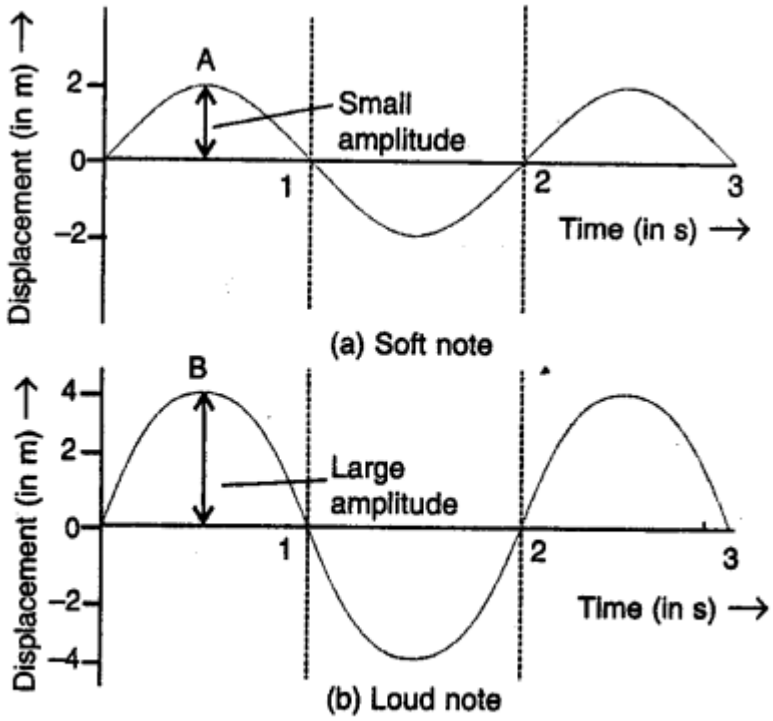
Question 5.
Obtain relationship between the time period and frequency.
Answer:
RELATIONSHIP BETWEEN THE TIME PERIOD (T) and FREQUENCY (f): By

definition time period is the time taken to complete 1 vibration
Or
In time T, number of vibration= 1
∴ In 1 second, the frequency or number of vibrations = 1 / T
f = 1 / T Or T = 1 / f

Question 6.
Name three characteristics of a musical sound.
Answer:
CHARACTERISTICS OF SOUND
Sounds can be distinguished from one another by the following three different characteristics:
(i) loudness
(ii) pitch or shrillness, and
(iii) quality or timbre.

Question 7.
Name the quantity from below which determines the loudness of a sound wave :
(a) Wavelength
(b) Frequency, and
(c) Amplitude.
Answer:
Quantity which determines loudness of a sound wave is (c) AMPLITUDE.

Question 8.
How is loudness related to the amplitude of wave ?
Answer:
Greater the amplitude, greater is the loudness.



Soft and loud sound

If we strike the drum gently, a faint sound is heard. But if we strike it hard, a loud sound is heard.

Question 9.
If the amplitude of a wave is doubled, what will be the effect on its loudness ?
Answer:
The loudness of sound is directly proportional to the sequare of amplitude of wave.
Loudness α $(\text{amplitude})^2$ When amplitude is doubled loudness becomes $(2)^2 = 4$ times

Question 10.
How does the wave pattern of a loud note differ from a soft note ? Draw a diagram.
Answer:
The amplitude of soft note (faint) has smaller amplitude.
The amplitude of loud sound has niore amplitude as shown in figure of Ans. 8.

Question 11.
Name the unit in which the loudness of sound is expressed.
Answer:
Unit of loudness _____ decible(dB)

Question 12.
Why is the loudness of sound heard by a plucked wire increased when mounted on a sound board ?

Answer:
A wire mounted on a sound board is plucked, the surface area of vibrating air increases and sends forth greater amount of energy, So the amplitude of vibration is large and louder is the sound.

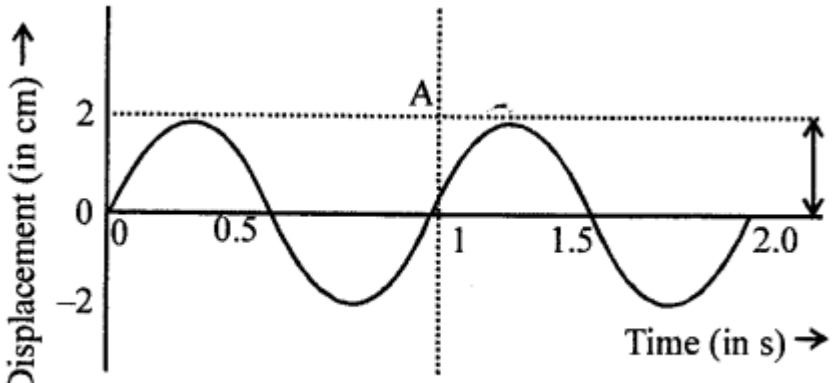
Question 13.
State three factors on which loudness of sound heard by a listener depends.
Answer:
THREE FACTOR FOR LOUDNESS OF SOUND :
(i) Surface area of sounding body. i.e. is directly proportional to surface area of vibrating body.
(ii) On the distance of source of sound, i.e. decreases with distance.
(iii) On AMPLITUDE OF WAVE: i.e. increases with amplitude.

Question 14.
What determines the pitch of a sound ?
Answer:
FREQUENCY/.e. number of vibrations per second determines the pitch. Higher frequency, higher pitch means shrill sound. A ‘ low pitch has flat sound.

Question 15.
Name the characteristic of sound related to its frequency.
Answer:
Characteristic of sound related to its frequency is PITCH.

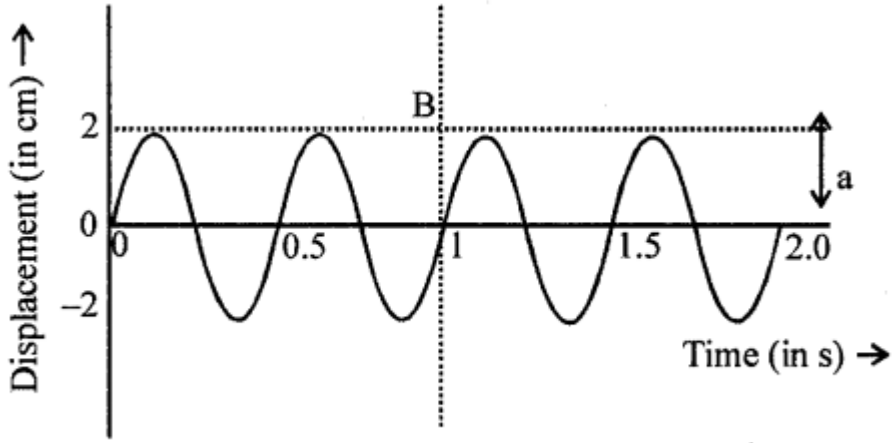
Question 16.
Name and define the characteristic which enables one to distinguish two sounds of same loudness, but of different frequencies, given by the same instrument.
Answer:
Two sounds of same loudness (amplitude) of different frequencies given by same instrument can be distinguished by the characteristics called PITCH.

Question 17.
Draw a diagram to show the wave pattern ofhigh pitch note and a low pitch note, but of the same loudness.
Answer:
PATTERN OF LOW PITCH AND HIGH PITCH NOTE :
LOW PITCH NOTE:



(a) Low pitch note (Frequency = 1 s^{-1})

HIGH PITCH NOTE:



(b) High pitch note (Frequency = 2 s^{-1})

Question 18.

How is it possible to detect the filling of a bucket under a water tap by hearing the sound standing at a distance ?

Answer:

The SOUND BECOMES SHRILLER AND SHRILLER as the water in the bucket rises, the length of air column decreases. So the frequency of the sound produced INCREASES. Thus by hearing the sound from a distance, one can get the idea of water level in the bucket

Question 19.

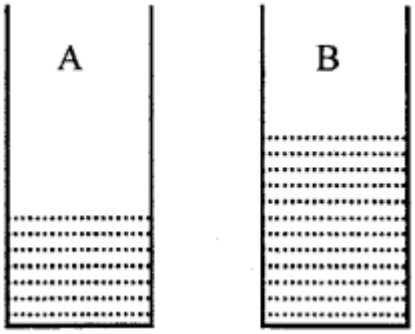
The frequencies of notes given by flute, guitar and trumpet are respectively 400 Hz, 200 Hz and 500 Hz. Which one of these has the highest pitch ?

Answer:

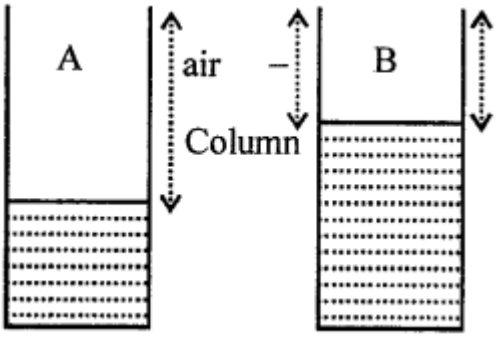
Instrument	Flute	Guitar	Trumpet
Frequency	400 Hz	200 Hz	500 Hz

The instrument with highest frequency has highest pitch.
Hence, trumpet frequency 5 00 Hz has highest pitch.

Question 20.
Figure shows two jars A and B containing water up to different heights. Which will produce sound of higher pitch when air is blown on them ?

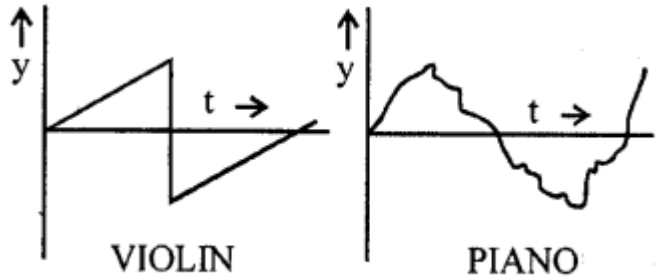


Answer:
Jar B which has less air column above water will produce sound of higher pitch.
Less air column produces increased frequency.



Question 21.
Two identical guitars are played by two persons to give notes of the same pitch. Will they differ in quantity ? Give reason for your answer.
Answer:
No_____They have same wave form.

Question 22.
Two musical notes of the same pitch and same loudness are played on two different instruments. Their wave patterns are as shown in figure.



How do they differ in
(a) loudness,
(b) pitch and
(c) quality

Answer:

(a) Loudness of each is same as amplitude is same.
(b) Pitch of each is same.
(c) Quality is DIFFERENT as the wave form is different

Question 23.

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

Answer:

Characteristic is TIMBER or QUALITY makes it possible to recognise a person by his voice without seeing him.

Question 24.

State the factors that determine
(a) the pitch of a note.
(b) the loudness of the sound heard.
(c) the quality of the note.

Answer:

(a) Frequency (b) Amplitude (c) Waveform

Question 25.

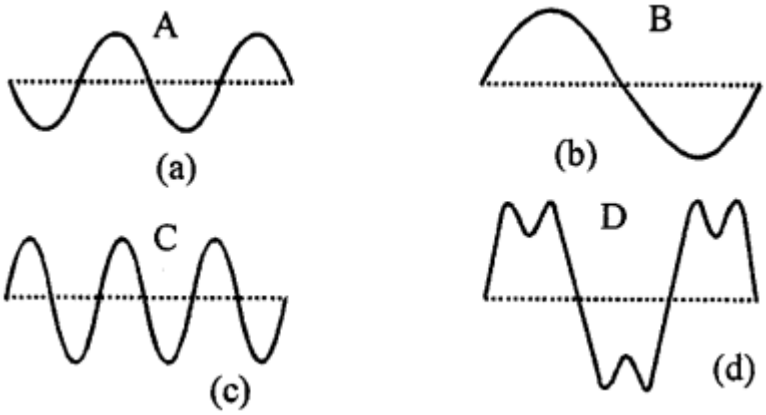
Name the characteristic of the sound affected due to a change in its (a) amplitude (b) wave form (c) frequency.

Answer:

(a) Loudness
(b) Quality
(c) Pitch.

Question 26.

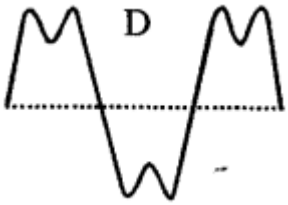
Figure shows four waves A, B, C, and D.



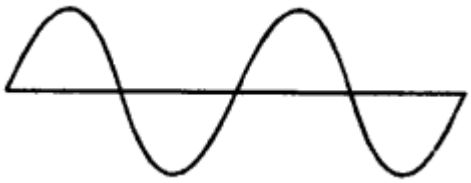
Name the wave which shows
(a)a note from a musical instrument,
(b)a soft note
(c) a shrill note.

Answer:

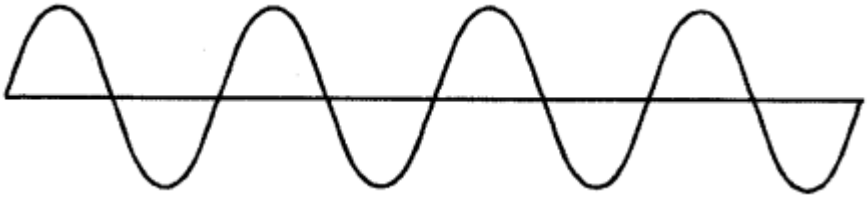
(a) a note from a musical sound is shown by (D)



(b) a soft note is shown by (A)



(c) a shrill note is shown by (C)



Question 27.

How is the pitch of sound in a guitar changed if (a) thin wire is used, (b) wire under less tension is used ?

Answer:

(a) Thin wire used ___ Higher pitch is obtained.
(b) Wire under less tension is used ___ a low pitch is obtained.

C. Numerical

Question 1.

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

Answer:

Loudness a^2

$(amplitude)^2$

(i) $\therefore$ Ratio of loudness

$$\frac{L_1}{L_2} = \frac{(a_1)^2}{(a_2)^2} = \frac{(1)^2}{(3)^2} = \frac{1}{9} = 1:9$$

(ii) Two waves of same pitch

$$\therefore \frac{\text{Pitch of first wave}}{\text{Pitch of second wave}} = \frac{1}{1} = 1:1$$

Question 2.

Two waves have frequencies 256 Hz and 512 Hz, but same amplitude. Compare their (i) loudness, and (ii) pitch;

Answer:

(i) LOUDNESS

$\therefore$ Amplitude of two waves ,is same

$\therefore$ their loudness is same i.e. in 1:1

(ii) PITCH:

Ratio of frequencies

256 Hz: 512 Hz

$\therefore$ Ratio of their pitch =1:2