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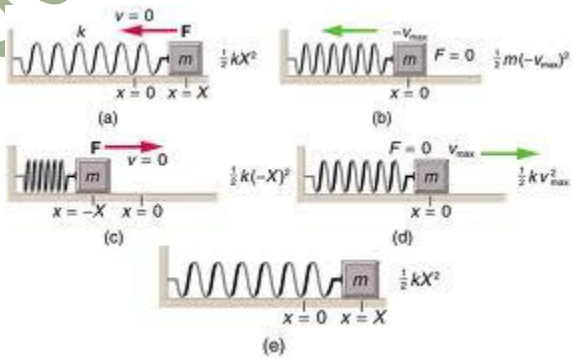
Waves and Sound

Q1. Define Simple Harmonic Motion?

Ans: The vibratory motion of a mass attached to a spring is called simple harmonic motion. The motion in which acceleration is always proportional to its displacement and the acceleration is always directed towards the equilibrium position is called simple harmonic motion.

Q2. Derive the expression of Simple Harmonic Motion.

Ans: SIMPLE HARMONIC MOTION:



Consider a block al rest in its equilibrium position on a frictionless the block to right, there will be a restoring force "F" exerted on the block by the spring and this force is directed to the left according to Hook's.

$F \propto -X$

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$$F = -Kx$$

Since direction of displacement is opposite to that of restoring force. According to Newton's second law.

$$F = ma = - Kx$$

$$a = -\frac{Kx}{m}$$

This is basic equation of motion for an object undergoing simple harmonic motion.

Since, K = constant and mass = constant

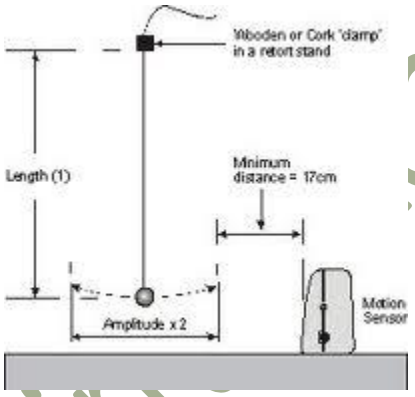
$$a = -(\text{constant}) X$$

$$a = - - \frac{Kx}{m}$$

$$a = - (\text{displacement})$$

Q3. Define simple Harmonic Motion with the help of:

(a) pendulum (b) mass suspended by a spring



Ans: (a) PENDULUM:

Motion of pendulum is simple harmonic motion because when pendulum is moved from its mean position a restoring force is set which is always opposite to the direction in which it is displaced.

(b) MASS SUSPENDED BY A SPRING:

When mass is suspended by a spring, and it is moved downwards a restoring force is set which is always opposite to the direction in which it is displaced.

Q4. Define the following terms:

i. Vibration ii. Time iii. Period iv. Frequency

v. Displacement

Ans: i. Vibration:

A vibration means one complete round trip of a body e.g. incase of simple pendulum if it is displaced to its max value it will move to other extreme value and returns back to the initial point this is one vibration.

(ii) TIME PERIOD:

It is the time required to complete one vibration or oscillation. It is measured in seconds.

(iii) FREQUENCY

It is the no. of vibrations in one second. It is expressed as vibration /sec, cycles/sec or hertz. It is denoted by the reciprocal of time period.

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(IV) DISPLACEMENT:

Displacement of a vibrating body at any instant is, its distance from the equilibrium position at that instant.

(V) AMPLITUDE:

It is the maximum displacement of a body on either side of its equilibrium position.

Q5. Prove that motion of a simple pendulum is an example of Simple Harmonic Motion.

Ans: Simple Pendulum:

An ideal simple pendulum consists of a point mass Suspended by weights and inextensible string from A fixed support. If we displace the bob from its mean Position 'O' to a new point "A", it will move forwards "O" * under the motion of gravity. The bob will may come to rest as "O" but due to inertia it will continue to move towards a point "B". While moving from point "O" to "B" bob moves against the gravity so its velocity continues to decrease at "B". It becomes zero now bob once again moves from "B" to "O" under the action of gravity and from "O" to "A". This process is repeated again and again. As the bob is at its lowest point. Its potential energy is zero but kinetic energy is maximum whereas at the two extreme values kinetic energy becomes zero and potential energy known as transverse wave, waves produced in the string is an example of transverse wave.

LONGITUDINAL WAVE:

If the motion of the particles of the elastic medium is back and forth along the direction of propagation of the wave then this tube of wave is, known as longitudinal wave. Examples are the waves produced by waving the spring back and forth and sound wave in air is one of the examples of longitudinal.

Q6. What is Ripple Tank?

Ans: Take some water in a large tray take a meter rod to which a handle is attached. Dip the meter rod in water and move it up and down. As the meter rod vibrates waves once produced in the form of crest and trough. Place a small cork on the on the water as the waves pass over the cork, it will vibrate up and down perpendicular to the direction of the waves at its own place. This shows that as the wave travel along the water surface, water particles vibrate perpendicular to the direction of waves, but they do not leave their position.

Q7. What is the relation between, velocity, wave length and frequency?

Ans: Consider a wave of wave length " λ " and frequency " v " traveling with velocity "V " in required for the wave to travel a distance of one wave length "λ " so that.

$$\lambda = VT$$

The frequency of the wave is naturally determined by the frequency of vibrating particle.

$$v = I / T \text{ OR}$$

$$T = I / v$$

Substituting the value of "T" in equation.

$$\lambda = VT$$

$$\lambda = V / v$$

$$v = V / \lambda$$

$$V = v \lambda$$

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Q8. Define "Crest" and "Trough".

Ans: CREST

The projections of the waves are called crest.

TROUGH:

The depressions of the waves are called trough.

Q9. Define wave length.

Ans: WAVE LENGTH:

The distance below two consecutive crest and trough is called wave length. It is denoted by "λ " read as lambda.

Q10. What is sound wave?

Ans: SOUND WAVE:

The longitudinal waves that are due to a vibrating source and that are capable of producing a sensation in the auditory system are called "sound waves ".

Q11. What is mean by Resonance? Give its examples.

Ans: When the frequency of the driving force "V " is exactly equal to the natural frequency of the oscillator "n " the driving force imparts the maximum energy to the oscillator resulting in considerable increase in amplitude of vibration a condition called "Resonance".

Resonance occurs when ever a system is set-in oscillation at its own natural frequency as a result of impulses received from some other system which is vibrating with the same frequency.

Example:

While crossing the bridge, the soldiers are ordered not to march in steps but to break their steps. The reason is that the bridge receives periodic impulses by regular foot steps of a marching column of soldier if the time period of periodic impulses happens to by equal to the natural time period of the bridge, a vibration of dangerously large amplitude may be produced and bridge may collapse.

Q12. What are the characteristics of sound?

Ans: Following are the characteristics of sound.

a) INTENSITY AND LOUDNESS:

It is the average power crossing a unit area of surface perpendicular to the direction in which the sound waves are traveling.

In M.K.S.System unit of intensity I s watt per wave is proportional to the square of the amplitude of sound wave.

Loudness is closely related to intensity the loudness " L " and intensity level are related by

$$L = \frac{1}{16}\left(\frac{1}{L}\right)^{.03} I\ I$$

b) PITCH:

The frequency of pure sound is a physical quantity this frequency produces a stimulus to the ear. The sensation corresponding to this is called "Pitch" of sound. Pitch of sound depends upon frequency of the vibrating body. Pitch is measured in Hertz.

c) QUALITY:

Ear possesses great sensitivity to quality of sound. It is the quality which makes possible for us to distinguish among the voices of our friend even when they have been distorted by telephone transmission.

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Q13. Derive the expression of wave velocity.

Ans: The speed of a wave is the distance traveled by it in unit time (in the direction of wave).

$$\text{Velocity} = \frac{\text{Distance}}{\text{Time}} = \frac{\text{Wavelength}}{\textit{Time Period}}$$

$$V = \frac{\lambda}{T}$$

$$\text{But } T = \frac{1}{f}$$

$$\text{Hence } V = f\,\lambda$$

Q14. What are the two important properties of waves?

Ans: Bouncing back of wave from a surface is called reflection. The angle at which the wave is reflected is equal to the angle at which the wave is incident on the surface. Waves coming from the source and hitting on obstacle in berries called reflected waves have the same frequency because they are produced by the same source.

INTERFERENCE:

Interference means the interaction of two waves passing through the same require of space at the same time. When two sets of waves meet, they are neither reflected nor absorbed by each other one simply passes all the other. How was at that point where the algebraic sum of the displacements of the two separate waves.

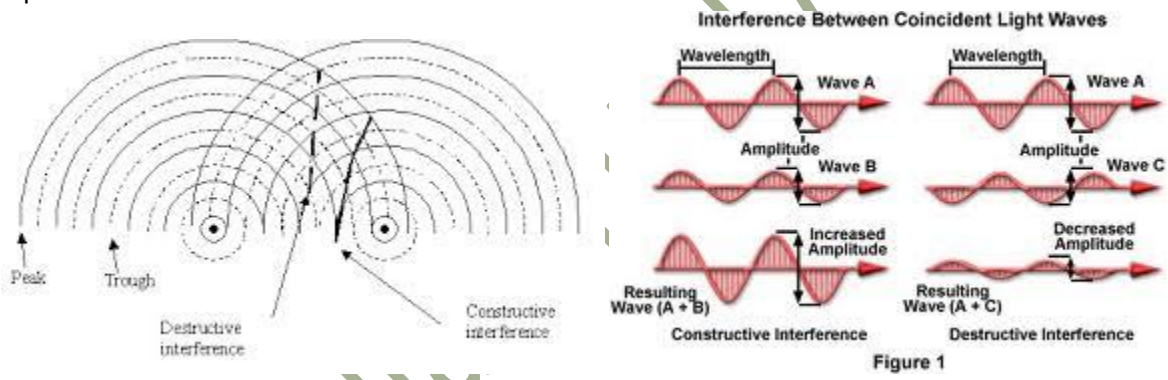

Figure 1

CONSTRUCTIVE INTERFERENCE:

If at a given point the crests or trough of the two waves a simultaneously then the combined waves is large than either of the two waves. This is called constructive interference.

DESTRUCTIVE INTERFERENCE:

If the crust of one wave arrives simultaneously with the trough of the other wave then the two will cancel each other and no wave will be of observed. This is called destructive interference.

Q15. Define Stationary Waves.

Ans: If two waves of the same amplitude and frequency traveling in opposite direction meet one another the resulting interference pattern gives rise to what are called standing waves or stationary waves.

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Q16. How is sound produced?

Ans: SOUND IS PRODUCED:

Sound is a form of energy which is produced by a vibrating body.

PROPAGATION OF SOUND WAVES:

When a body was is vibrating it produces a disturbance in the surround air. This distance reaches our ear in the form of waves this producing the sensation of sound.

Experiment:

Suspended an electric bell in a jar by its waves through a cork fined in its mouth. Switch on the bell. We will hear the sound of the bell. Now start remaining air from the jar with the help of an exhaust pump. The loudness of the wound of the bell will start decreasing. This experiment shows that the air is necessary for the propagation of sound.

Q17. What is an audible frequency range?

Ans: Our ear can hear only those sounds whose frequency is between 20 Hz to 20,000 Hz. That is, the ear can neither hear a sound of frequency less tan 20 Hz nor a sound of frequency greater than 2.0,000 Hz. A sound or frequency greater than 20,000 Hz can be produced but the human ear cannot detect it because ear drum cannot vibrate, with such a high frequency. The second having a frequency more than 20,000 is known as ultrasonic. The audible range (20 Hz to 20,000 Hz) is different, for different persons and it also varies with the age.

Q18. How is echo produced?

Ans: The sound heard after reflection from a surface is called an Echo. In a normal human ear the effect in the sensation of sound period for 1/10th of a second after the sound has ceased. If some sound enter the ear with in this interval of time it merges with the previous sound and does not appear to be separate . It hear an echo it is therefore necessary that the time elapsed between the production of a sound and the hearing of is echo is equal to or more than i/10th of a second.

Q19. Explain Beats.

Ans: Beats can be defined as the periodic variation in intensive at a given point due to the superimposition of two waves having slightly different frequencies. The number of beats one hears per second, or the best frequency is equal to the difference in frequency between the two sounds. The minimum beat frequency that a human ear can detect is beats per second.

EXAMPLE:

If two tuning forks of slightly different frequencies are struck we hear a sound of alternating high and low intensity this is called a beat and hence the phenomenon is popularly called beats.

Q20. Define Ultrasonic Waves.

Ans: DEFINITION:

i. Ultrasonic waves are longitudinal waves with frequency above the audible range. Ultrasonic waves are widely used as diagnostic, therapeutic, and surgical tools in medicine and in industrial application.

ii. Ultrasonic waves can be used echo-depth sounding devices to determine the depth of the sea.

iii. Sonar (sound navigation and ranging) is used because it units Ultrasound wavesand can be used to carry out the location of an object by its echo.

iv. Ultrasound are often preferred to x-ray scans, because Ultrasound is much refer
than x-rays.

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