Chapter 6. Superposition of Waves

MCQ's (1 Mark Each)

1) A standing wave is produced on a string fixed at one end with the other end free. The length of the string
   a. must be an odd integral multiple of λ
   b. must be an odd integral multiple of λ/2
   c. must be an odd integral multiple of λ/4
   d. must be an even integral multiple of λ

   Ans: c) must be an odd integral multiple of λ/4

2) The equation of a simple harmonic progressive wave is given by,
   $y = 5 \cos \pi [200t - x/150]$, where x and y are in cm and 't' is in second. Then the velocity of the wave is
   a) 2 m/s b) 150 m/s c) 200 m/s d) 300 m/s

   Ans: c) 200 m/s

3) A man standing unsymmetrical position between two mountains and fires a gun. He hears the first echo after 1.5 s and the second echo after 2.5 s. If the speed of sound in air is 340 m/s, then the distance between the mountains will be
   a. 400 m
   b. 520 m
   c. 640 m
   d. 680 m

   Ans: d) 680 m

4) A set of tuning forks is arranged is ascending order of frequencies each tuning fork gives 8 beats/s with the preceding one. If frequency of the first tuning fork is 120 Hz and the last fork is 200 Hz, then the number of tuning forks arranged will be,
   a. 8
   b. 9
   c. 10
   d. 11

   Ans.: d) 11

5) In law of tension, the fundamental frequency of vibrating string is,

a. inversely proportional to square root of tension
b. directly proportional to the square of tension
c. directly proportional to the square root of tension
d. inversely proportional to density

Ans: c) directly proportional to the square root of tension

6) The integral multiple of fundamental frequencies are
a. beats
b. resonance
c. overtones
d. harmonics

Ans: d) harmonics

7) An organ pipe of length 0.4 m is open at both ends. The speed of sound in air is 340 m/s. The fundamental frequency is,
a. 405 Hz
b. 415 Hz
c. 425 Hz
d. 435 Hz

Ans: c) 425 Hz

Very Short Answer (VSA) (1 MARK Each)

1) A wave is represented by an equation y = A Sin (Bx + Ct). Given that the constants A, B and C are positive, can you tell in which direction the wave is moving?
2) Why wave motion is doubly periodic?
3) What is interference of sound waves?
4) What are beats?
5) What are harmonics?
6) What are overtones?
7) State law of length.
8) State law of tension.
9) State law of linear density.
10) What is the resonance?
11) What are forced vibrations?
12) State any one characteristics of sound.

13) A violin string vibrates with a fundamental frequency of 510 Hz. What is the frequency of the first overtone? **(Ans*: $n_1 = 1020$ Hz)***

14) A string 1 m long is fixed at one end. The other end is moved up and down with frequency 20 Hz. Due to this, a stationary wave with four complete loops, gets produced on the string. Find the speed of the progressive wave which produces the stationary wave. [Note: Remember that the moving end is a antinode**.]** **(Ans*: V = 10 m/s)***

Short Answer I (SA1) (2 MARKS Each)

1) For a stationary wave set up in a string having both ends fixed, what is the ratio of the fundamental frequency to the third harmonic?
2) What are stationary waves? Why are they called stationary wave?
3) Distinguish between overtone and harmonic.
4) State any four applications of beats.
5) Prove that a pipe opens at both end of length of 2L, has the same fundamental frequency as another pipe of closed at one end of length L.
6) How is the frequency of vibrating wire affected if the load is fully immersed in water?
7) A sonometer wire of length 1 m is stretched by a weight of 10 kg. The fundamental frequency of vibration is 100 Hz. Determine the linear density of material of wire.

(Ans: $m = 0.0025 \times 10^{-4}$ kg/m)

Short Answer II (SA2) (3 MARKS Each)

1) Find the amplitude of the resultant wave produced due to interference of two waves given as,

   $y_1 = A_1 \sin \omega t$, $y_2 = A_2 \sin (\omega t + \phi)$
2) Show that even as well as odd harmonics are present as overtone in modes of vibration of string.
3) State and explain laws of vibrating strings.
4) Write a short note on Quality or timbre.
5) Two wires of the same material and same cross section are stretched on a sonometer. One wire is loaded with 1 kg and another is loaded with 9 kg. The vibrating length of first wire is 60 cm and its fundamental frequency of vibration is the same as that of the second wire. Calculate vibrating length of the other wire. *(Ans: 3)*
6) The equation of simple harmonic progressive wave is, $y = \sin \pi/2 (4t/0.025 – x/0.25)$. Where all quantities are in S.I. system. Find amplitude, frequency, wavelength and

velocity of wave. ***(Ans: Amplitude, A = 1 m Frequency n = 40 Hz Wavelength λ = 1 m, v = 40 m/sec)***

7) A stretched sonometer wire is in unison with a tuning fork. When the length is increased by 4%, the number of beats heard per second is 6. Find the frequency of the fork. ***(Ans: n_1 = 156 Hz)***

Long Answer (LA) (4 marks Each)

1) Explain the formulation of stationary waves by analytical method. What are nodes and antinodes? Show that the distance between two successive nodes or antinodes is λ/2.
2) Explain the production of beats and deduce analytically the expression for beats frequency.
3) State and verify the laws of vibrating strings using sonometer.
4) Explain the reflection of transverse waves from a denser medium.
5) Explain the reflection of Longitudinal waves from a rarer medium.
6) Waves produced by two vibrators in a medium have wavelength 2 m and 2.1 m respectively. When sounded together they produce 8 beats/second. Calculate wave velocity and frequencies of the vibrators. ***(Ans: n_1 = 168 Hz)***