Chapter15.
Waves

I. One mark questions (PART – A):

1. What is wave?(K)
2. What are mechanical waves?(K)
3. Give an example for mechanical wave.(U)
4. What are electromagnetic waves?(K)
5. Give an example for non mechanical waves.(U)
6. What are transverse waves?(K)
7. Give an example for transverse wave.(U)
8. How does speed of a transverse wave on a stretched string vary with its tension ?(U)
9. What are longitudinal waves?(K)
10. Give an example for longitudinal wave.(U)
11. How does speed of sound in air changes with temperature?(U)
12. Why a transverse mechanical wave cannot travel in gases?(S)
13. What is a progressive wave?(K)
14. Define amplitude of a wave.(K)
15. Define wavelength of a wave.(K)
16. Define period of a wave.(K)
17. Define frequency of a wave.(K)
18. Define wave velocity.(K)
19. What do you mean by phase of a wave?(K)
20. Write the expression for propagation constant (angular wave number).(U)
21. Write the expression for angular frequency in terms of frequency.(U)
22. Give the relation between frequency and time period.(U)
23. Write the relation between velocity, frequency and wavelength.(U)
24. State the principle of superposition of waves.(K)
25. Give an example for principle of superposition of waves.(U)
26. How much phase change occur during the reflection of a progressive wave at the rigid boundary?(U)
27. How much phase change occur during the reflection of a progressive wave at the open boundary?(U)
28. What are standing (stationary) waves?(K)
29. What are nodes in a stationary wave?(K)
30. What are antinodes in a stationary wave?(K)
31. What is the distance between node and consecutive antinode? (K)
32. What is the length of a segment/loop in a stationary wave?(K)
33. What are normal modes of vibrations?(K)
34. What is mean by fundamental mode of vibration?(K)
35. What are harmonic frequencies of vibration?(K)
36. What are overtones?(K)

37. What is a closed pipe?(K)
38. What is an open pipe?(K)
39. What harmonics are present in a stretched string?(K)
40. What harmonics are present in a closed pipe?(K)
41. What harmonics are present in an open pipe?(K)
42. What are beats?(K)
43. Define beat frequency.(K)
44. Define beat period.(K)
45. Write relation between beat frequency and frequency of individual waves.(U)
46. What is Doppler effect?(K)

Two mark questions (PART – B):

1. Which properties of the medium are necessary for the propagation of mechanical wave?(U)
2. Write the expression for displacement of a particle in a progressive wave. Explain the terms involved.(U)
3. Give the relation between phase difference and path difference. Explain the terms involved. (U)
4. Write the expression for speed of transverse wave in the stretched string. Explain the terms involved.(U)
5. Write the expression for speed of longitudinal wave in the elastic medium. Explain the terms involved.(U)
6. Write the expression for speed of longitudinal wave in a solid bar (OR stretched sting). Explain the terms involved.(U)
7. Write Newton's formula for speed of sound in air. Explain the terms involved.(U)
8. Write Newton's-Laplace formula for speed of sound in air. Explain the terms involved.(U)
9. How does speed of sound in air vary with pressure and humidity?(U)
10. State and explain principle of superposition of waves.(K)
11. Write the equation for fundamental frequency of a stretched string, and explain the terms.(U)
12. Write the expression for fundamental frequency of a closed pipe, and explain the terms.(U)
13. Write the expression for fundamental frequency of an open pipe. Explain the terms involved.(U)
14. Give two applications of beats.(A)
15. Write the expression for apparent frequency of sound, when source is moving away from a stationary observer. Does the apparent frequency increase or decrease?(U)
16. Give the expression for apparent frequency of sound, when source is moving towards a stationary observer. Explain the terms involved.(U)
17. Write the expression for apparent frequency of sound, when both source and observer moving in the same direction. Explain the terms.(U)
18. Give two applications of Doppler effect.(A)

Three mark questions (PART – C):

1. Explain different types of waves based on modes of vibration of the particles of the medium with examples.(U)
2. Distinguish between longitudinal and transverse wave.(U)
3. Derive the relation between wave velocity, wave frequency and wavelength.(U)
4. Explain Laplace's correction for Newton's formula.(U)

5. Distinguish between progressive and stationary waves.(U)
6. Derive the expression for apparent frequency of sound, when an observer is moving towards a stationary source.(U)

Five mark questions (PART – D):

1. Deduce Newton's formula for speed of sound in air. Why it requires correction**?** (U)
2. Write Newton's formula for speed of sound in air. Explain Laplace's correction for it.(U)
3. Give the theory of standing wave.(U)
4. Show that all harmonics are present in vibrating stretched string. OR Discuss the modes of vibration in a stretched string.(U)
5. What is closed pipe? Prove that the overtones in a closed pipe are odd harmonics.(U)
6. What is open pipe? Prove that the all harmonics are present in an open pipe.(U)
7. Give the theory of beats.(U)
8. Derive the expression for apparent frequency of sound in the case of moving source and stationary observer.(U)
9. Derive the expression for apparent frequency of sound in the case of both source and observer moving.(U)

Five marks problems…

1. A wave travelling along a string is described by, y = $0.002\sin(75x - 5t)$. Where x and y are in metre and t is in second. Calculate a) amplitude b) wavelength c) period d) frequency e) wave velocity. (S) **[Ans- a) 0.002 m b) 0.084 m c) 1.257 s d) 0.796 Hz e) 0.067 ms^{-1}]**
2. A transverse harmonic wave on a string is described by y = $5\sin(26t + 0.02x + \frac{\pi}{2})$. Where x and y are in centimetre and t is in second. Calculate; amplitude, wave velocity and initial phase at the origin. Find the displacement of the particle at t = $\frac{\pi}{26}$ s and x = 0. (S)
   (Ans- 0.05 m, 1300 ms^{-1}, $\frac{\pi}{2}$, - 0.05 m)
3. A string of mass 3 kg is under a tension of 150 N. The length of the stretched string is 27 m. If the transverse jerk is struck at one end of the string, calculate the speed of the wave and the time taken by the wave to reach the other end of the string. (S)
   (Ans- 36.742 ms^{-1}, 0.735 s)
4. Calculate the speed of sound in air at STP. The mass of 1 mole of air is 29 x 10^{-3} kg, and ratio of specific heats of air is 1.4. (S) **(Ans- 330.93 ms^{-1})**
5. A stretched string emits a note of fundamental frequency of 256 Hz. When the tension is increased by 2 kgwt, the frequency of the fundamental rises to 312 Hz. Find the initial tension and the length of the wire. (Linear density of the string is 1.5 x 10^{-3} kgm^{-1}) (S)
   (Ans- 4.12 kgwt, 0.32 m)
6. Two strings A and B are slightly out of tune and produce beats of frequency 8 Hz. The tension in the string A is slightly increased and beat frequency is found to reduced to 2 Hz. If the original frequency of A is 445 Hz, what is the frequency of B ?. Also calculate the frequency of A after the change of tension. (S)
   (Ans- 453 Hz, 451 Hz)

7. A pipe of 24.5 cm long is closed at one end. Which harmonic mode of the pipe resonates with a source of frequency 345 Hz ?. Will the same source be in resonance with the pipe if both ends are open? (speed of sound in air is 340 ms^{-1}) (S)

(Ans- First harmonic of the pipe resonates with the source, Pipe cannot resonate with the source.)

8. Two organ pipes one open at both ends and the other closed at one end give their fundamental notes of frequencies which differ by 27 Hz. The length of the closed pipe is 0.76 m. Calculate the length of the open pipe, if the velocity of sound in air is 340 ms^{-1}. (S) **(Ans- 1.224 m)**

9. A source of sound is moving at a speed of 20 ms^{-1} towards a wall. While moving, it emits a wave of frequency 600 Hz. Some of the sound reaching the wall gets reflected back to the source as an echo. If the speed of sound in air is 340 ms^{-1}, calculate ; a) the frequency of sound as detected by the observer near the wall. b) the frequency of the echo as detected by the observer at the source. (S) **(Ans- 637.5 Hz , 675 Hz)**

10. A train , standing at the outer signal of a railway station blows a whistle oa frequency 550 Hz in still air. If the speed of sound in air is 340 ms^{-1}, estimate the frequency of the whistle as heard by an observer on the platform as train, a) approaches the platform with a speed of 15 ms^{-1} b) recedes from the platform with a speed of 15 ms^{-1} c) What will be the speed of the sound in each case ? (S) **(Ans- 575.4 Hz , 526.76 Hz , 340 ms^{-1})**

11. A car with a velocity 20 ms^{-1} approaches a train which is sounding a whistle of frequency 800 Hz. If velocity of sound is 335 ms^{-1}, calculate the frequency of the note heard by a person in the car when the train is a) stationary b) moving with a velocity 10 ms^{-1} in the direction of the car.(S)

(Ans- 847.76 Hz, 823.19 Hz)