Wave Motion

1. **When a sound wave of frequency 300 Hz passes through a medium the maximum displacement of a particle of the medium is 0.1 cm. The maximum velocity of the particle is equal to**

   (a) 60 π cm/sec (b) 30 π cm/sec

   (c) 30 cm/sec (d) 60 cm/sec

2. **In a sinusoidal wave, the time required for a particular point to move from maximum displacement to zero displacement is 0.170 second. The frequency of the wave is**

   (a) 1.47 Hz (b) 0.36 Hz

   (c) 0.73 Hz (d) 2.94 Hz

3. **A stone is dropped into a lake from a tower 500 meter high. The sound of the splash will be heard by the man approximately after**

   (a) 11.5 seconds (b) 21 seconds

   (c) 10 seconds (d) 14 seconds

4. **When sound waves travel from air to water, which of the following remains constant**

   (a) Velocity (b) Frequency

   (c) Wavelength (d) All the above

5. **The speed of a wave in a medium is 760 m/s. If 3600 waves are passing through a point, in the medium in 2 minutes, then its wavelength is**

   (a) 13.8 m (b) 25.3 m

   (c) 41.5 m (d) 57.2 m

6. **The temperature at which the speed of sound in air becomes double of its value at $0^{o}C$ is**

   (a) 273K (b) 546K

(c) 1092K (d) 0K

7. If wavelength of a wave is $\lambda = 6000\,\AA$. Then wave number will be

(a) 166×10^{3} m^{-1} (b) 16.6×10^{-1} m^{-1}

(c) 1.66×10^{6} m^{-1} (d) 1.66×10^{7} m^{-1}

8. Velocity of sound measured in hydrogen and oxygen gas at a given temperature will be in the ratio

(a) 1 : 4 (b) 4 : 1

(c) 2 : 1 (d) 1 : 1

9. Find the frequency of minimum distance between compression & rarefaction of a wire. If the length of the wire is 1m & velocity of sound in air is 360 m/s

(a) 90 sec^{-1} (b) 180s^{-1}

(c) 120 sec^{-1} (d) 360 sec^{-1}

10. The velocity of sound is v_s in air. If the density of air is increased to 4 times, then the new velocity of sound will be

(a) $\frac{v_s}{2}$ (b) $\frac{v_s}{12}$

(c) $12v_s$ (d) $\frac{3}{2}v_s^2$

11. It takes 2.0 seconds for a sound wave to travel between two fixed points when the day temperature is 10^{o}C. If the temperature rise to 30^{o}C the sound wave travels between the same fixed parts in

(a) 1.9 sec (b) 2.0 sec

(c) 2.1 sec (d) 2.2 sec

12. If v_m is the velocity of sound in moist air, v_d is the velocity of sound in dry air, under identical conditions of pressure and temperature

(a) $v_m > v_d$ (b) $v_m < v_d$

(c) $v_m = v_d$ (d) $v_m v_d = 1$

13. A man, standing between two cliffs, claps his hands and starts hearing a series of echoes at intervals of one second. If the speed of sound in air is 340 ms^{-1}, the distance between the cliffs is

(a) 340 m (b) 1620 m

(c) 680 m (d) 1700 m

14. A source of sound of frequency 600 Hz is placed inside water. The speed of sound in water is 1500 m/s and in air is 300 m/s. The frequency of sound recorded by an observer who is standing in air is

(a) 200 Hz (b) 3000 Hz

(c) 120 Hz (d) 600 Hz

15. If the temperature of the atmosphere is increased the following character of the sound wave is effected

(a) Amplitude (b) Frequency

(c) Velocity (d) Wavelength

16. An underwater sonar source operating at a frequency of 60 KHz directs its beam towards the surface. If the velocity of sound in air is 330 m/s, the wavelength and frequency of waves in air are:

(a) 5.5 mm, 60 KHz (b) 330 m, 60 KHz

(c) 5.5 mm, 20 KHz (d) 5.5 mm, 80 KHz

17. Two sound waves having a phase difference of 60° have path difference of

(a) 2λ (b) λ/2

(c) λ/6 (d) λ/3

18. Water waves are

(a) Longitudinal

(b) Transverse

(c) Both longitudinal and transverse

(d) Neither longitudinal nor transverse

19. Transverse waves can propagate in

(a) Liquids (b) Solids

(c) Gases (d) None of these

20. Sound waves in air are

(a) Transverse (b) Longitudinal

(c) De-Broglie waves (d) All the above

21. Which of the following is not the transverse wave

(a) X-rays (b) γ -rays

(c) Visible light wave (d)Sound wave in a gas

22. What is the phase difference between two successive crests in the wave

(a) π (b) $\pi/2$

(c) 2π (d) 4π

23. A wave of frequency 500 Hz has velocity 360 m/sec. The distance between two nearest points 60° out of phase, is

(a) 0.6 cm (b) 12 cm

(c) 60 cm (d) 120 cm

24. The following phenomenon cannot be observed for sound waves

(a) Refraction (b) Interference

(c) Diffraction (d) Polarisation

25. When an aero plane attains a speed higher than the velocity of sound in air, a loud bang is heard. This is because

(a) It explodes

(b) It produces a shock wave which is received as the bang

(c) Its wings vibrate so violently that the bang is heard

(d) The normal engine noises undergo a Doppler shift to generate the bang

26. The equation of a transverse wave is given by $y = 10 \sin \pi (0.01x - 2t)$ where x and y are in cm and t is in second. Its frequency is

(a) $10 \sec^{-1}$ (b) $2 \sec^{-1}$

(c) $1 \sec^{-1}$ (d) $0.01 \sec^{-1}$

27. Two waves are given by $y_1 = a\sin(\omega t - kx)$ and $y_2 = a\cos(\omega t - kx)$ The phase difference between the two waves is

(a) $\frac{\pi}{4}$ (b) π

(c) $\frac{\pi}{8}$ (d) $\frac{\pi}{2}$

28. A wave is reflected from a rigid support. The change in phase on reflection will be

(a) $\pi / 4$ (b) $\pi / 2$

(c) π (d) 2π

29. The equation of a wave travelling in a string can be written as $y = 3\cos \pi(100\, t - x)$. Its wavelength is

(a) 100 cm (b) 2 cm

(c) 5 cm (d) None of the above

30. A transverse wave is described by the equation $Y = Y_0 \sin 2\pi\left(ft - \frac{x}{\lambda}\right)$. The maximum particle velocity is four times the wave velocity if

(a) $\lambda = \frac{\pi Y_0}{4}$ (b) $\lambda = \frac{\pi Y_0}{2}$

(c) $\lambda = \pi Y_0$ (d) $\lambda = 2\pi Y_0$

31. A transverse wave is represented by the equation

$$y = y_0 \sin \frac{2\pi}{\lambda}(vt - x)$$

For what value of λ, the maximum particle velocity equal to two times the wave velocity

(a) $\lambda = 2\pi y_0$ (b) $\lambda = \pi y_0 / 3$

(c) $\lambda = \pi y_0 / 2$ (d) $\lambda = \pi y_0$

32. A travelling wave in a stretched string is described by the equation $y = A\sin(kx - \omega t)$**. The maximum particle velocity is**

(a) Aω (b) ω/k

(c) dω/dk (d) x/t

33. A wave travels in a medium according to the equation of displacement given by $y(x,t) = 0.03\sin\pi(2t - 0.01x)$ **.Where y and x are in meters and t in seconds. The wavelength of the wave is**

(a) 200 m (b) 100 m

(c) 20 m (d) 10 m

34. The equation of a sound wave is $y = 0.0015\sin(62.4x + 316t)$ **The wavelength of this wave is**

(a) 0.2 unit (b) 0.1 unit

(c) 0.3 unit (d) Cannot be calculated

35. If the equation of transverse wave is $y = 5\sin 2\pi\left[\frac{t}{0.04} - \frac{x}{40}\right]$**, where distance is in cm and time in second, then the wavelength of the wave is**

(a) 60 cm (b) 40 cm

(c) 35 cm (d) 25 cm

36. A wave is represented by the equation : $y = a\sin(0.01x - 2t)$ **where a and x are in cm. velocity of propagation of wave is**

(a) 10 cm/s (b) 50 cm/s

(c) 100 cm/s (d) 200 cm/s

37. The equation of a longitudinal wave is represented as $y = 20\cos\pi(50t - x)$**. Its wavelength is**

(a) 5 cm (b) 2 cm

(c) 50 cm (d) 20 cm

38. A wave travelling in positive X-direction with $A = 0.2m$ has a velocity of 360 m/sec. if $\lambda = 60m,$ then correct expression for the wave is

(a) $y = 0.2\sin\left[2\pi\left(6t + \frac{x}{60}\right)\right]$ (b) $y = 0.2\sin\left[\pi\left(6t + \frac{x}{60}\right)\right]$

(c) $y = 0.2\sin\left[2\pi\left(6t - \frac{x}{60}\right)\right]$ (d) $y = 0.2\sin\left[\pi\left(6t - \frac{x}{60}\right)\right]$

39. The equation of a wave motion (with t in seconds and x in meters) is given by $y = 7\sin\left[7\pi t - 0.4\pi x + \frac{\pi}{3}\right]$. The velocity of the wave will be

(a) 17.5 m/s (b) 49π m/s

(c) $\frac{49}{2\pi} m/s$ (d) $\frac{2\pi}{49} m/s$

40. Two waves represented by the following equations are travelling in the same medium $y_1 = 5\sin 2\pi(75t - 0.25x)$, $y_2 = 10\sin 2\pi(150t - 0.50x)$

The intensity ratio I_1/I_2 of the two waves is

(a) 1 : 2 (b) 1 : 4

(c) 1 : 8 (d) 1 : 16

41. The equation of a progressive wave is $y = 8\sin\left[\pi\left(\frac{t}{10} - \frac{x}{4}\right) + \frac{\pi}{3}\right]$. The wavelength of the wave is

(a) 8 m (b) 4 m

(c) 2 m (d) 10 m

42. Which of the following is not true for this progressive wave $y = 4\sin 2\pi\left(\frac{t}{0.02} - \frac{x}{100}\right)$ where y and x are in cm & t in sec

(a) Its amplitude is 4 cm

(b) Its wavelength is 100 cm

(c) Its frequency is 50 cycles/sec

(d) Its propagation velocity is 50×10^3 cm/sec

43. The equation of a wave is given as $y = 0.07 \sin(12\pi x - 3000\pi t)$. Where x is in meter and t in sec, then the correct statement is

(a) $\lambda = 1/6 m, v = 250 m/s$ (b) $a = 0.07 m, v = 300 m/s$

(c) $n = 1500, v = 200 m/s$ (d) None

44. The equation of the propagating wave is $y = 25 \sin(20t + 5x)$, where y displacement is. Which of the following statement is not true

(a) The amplitude of the wave is 25 units.

(b) The wave is propagating in positive x-direction.

(c) The velocity of the wave is 4 units.

(d) The maximum velocity of the particles is 500 units.

45. In a plane progressive wave given by $y = 25\cos(2\pi t - \pi x)$, the amplitude and frequency are respectively

(a) 25,100 (b) 25, 1

(c) 25, 2 (d) 50π, 2

46. The displacement y of a wave travelling in the x-direction is given by $y = 10^{-4} \sin\left(600t - 2x + \frac{\pi}{3}\right)$ meters, where x is expressed in metres and t in seconds. The speed of the wave-motion, in ms^{-1}, is

(a) 200 (b) 300

(c) 600 (d) 1200

47. The displacement y of a particle in a medium can be expressed as: $y = 10^{-6} \sin(100t + 20x + \pi/4) m$, where t is in second and x in meter. The speed of wave is

(a) 2000 m/s (b) 5 m/s

(c) 20 m/s (d) 5π m/s

48. If the wave equation $y = 0.08 \sin\frac{2\pi}{\lambda}(200t - x)$ then the velocity of the wave will be

(a) $400\sqrt{2}$ (b) $200\sqrt{2}$

(c) 400 (d) 200

49. The phase difference between two waves represented by

$y_1 = 10^{-6}\sin[100\,t + (x/50) + 0.5]m$

$y_2 = 10^{-6}\cos[100\,t + (x/50)]m$

Where x is expressed in meters and t is expressed in seconds, is approximately

(a) 1.5 rad (b) 1.07 rad

(c) 2.07 rad (d) 0.5 rad

50. Equation of motion in the same direction are given by $y_1 = 2a\sin(\omega t - kx)$ **and** $y_2 = 2a\sin(\omega t - kx - \theta)$ **The amplitude of the medium particle will be**

(a) $2a\cos\theta$ (b) $\sqrt{2}a\cos\theta$

(c) $4a\cos\theta/2$ (d) $\sqrt{2}a\cos\theta/2$

51. A particle on the trough of a wave at any instant will come to the mean position after a time (T = time period)

(a) $T/2$ (b) $T/4$

(c) T (d) $2T$

52. If the equation of transverse wave is $Y = 2\sin(kx - 2t)$, **then the maximum particle velocity is**

(a) 4 units (b) 2 units

(c) 0 (d) 6 units

53. Equation of motion in the same direction is given by $y_1 = A\sin(\omega t - kx)$, $y_2 = A\sin(\omega t - kx - \theta)$**. The amplitude of the medium particle will be**

(a) $2A\cos\frac{\theta}{2}$ (b) $2A\cos\theta$

(c) $\sqrt{2}A\cos\frac{\theta}{2}$ (d) $1.2f, 1.2\lambda$

54. Two waves having the intensities in the ratio of 9: 1 produce interference. The ratio of maximum to the minimum intensity, is equal to

(a) 2 : 1 (b) 4 : 1

(c) 9 : 1 (d) 10 : 8

55. The displacement of the interfering light waves are $y_1 = 4\sin\omega t$ **and** $y_2 = 3\sin\left(\omega t + \frac{\pi}{2}\right)$**. What is the amplitude of the resultant wave**

(a) 5 (b) 7

(c) 1 (d) 0

56. The equation of stationary wave along a stretched string is given by $y = 5\sin\frac{\pi x}{3}\cos 40\pi t$**, where x and y are in cm and t in second. The separation between two adjacent nodes is**

(a) 1.5 cm (b) 3 cm

(c) 6 cm (d) 4 cm

57. A wave represented by the given equation $y = a\cos(kx - \omega t)$ **is superposed with another wave to form a stationary wave such that the point x = 0 is a node. The equation for the other wave is**

(a) $y = a\sin(kx + \omega t)$ (b) $y = -a\cos(kx + \omega t)$

(c) $y = -a\cos(kx - \omega t)$ (d) $y = -a\sin(kx - \omega t)$

58. A standing wave having 3 nodes and 2 antinodes is formed between two atoms having a distance 1.21 Å between them. The wavelength of the standing wave is

(a) 1.21 Å (b) 2.42 Å

(c) 6.05 Å (d) 3.63 Å

59. A standing wave is represented by $Y = A\sin(100\,t)\cos(0.01\,x)$ **where Y and A are in millimeter, t is in seconds and x is in meter. The velocity of wave is**

(a) $10^4\ m/s$

(b) $1\,m/s$

(c) $10^{-4}\ m/s$

(d) Not derivable from above data

60. Equation of a stationary wave is $y = 10\sin\frac{\pi x}{4}\cos 20\pi t$. **Distance between two consecutive nodes is**

(a) 4 (b) 2

(c) 1 (d) 8

61. At nodes in stationary waves

(a) Change in pressure and density are maximum

(b) Change in pressure and density are minimum

(c) Strain is zero

(d) Energy is minimum

62. Consider the three waves z_1, z_2 **and** z_3 **as** $z_1 = A\sin(kx - \omega t)$, $z_2 = A\sin(kx + \omega t)$ **and** $z_3 = A\sin(ky - \omega t)$. **Which of the following represents a standing wave?**

(a) $z_1 + z_2$ (b) $z_2 + z_3$

(c) $z_3 + z_1$ (d) $z_1 + z_2 + z_3$

63. The following equations represent progressive transverse waves $Z_1 = A\cos(\omega t - kx)$, $Z_2 = A\cos(\omega t + kx)$, $Z_3 = A\cos(\omega t + ky)$ **and** $Z_4 = A\cos(2\omega t - 2ky)$. **A stationary wave will be formed by superposing**

(a) Z_1 and Z_2 (b) Z_1 and Z_4

(c) Z_2 and Z_3 (d) Z_3 and Z_4

64. Two travelling waves $y_1 = A\sin[k(x - c\,t)]$ **and** $y_2 = A\sin[k(x + c\,t)]$ **are superimposed on string. The distance between adjacent nodes is**

(a) $c\,t/\pi$ (b) $c\,t/2\pi$

(c) $\pi/2k$ (d) π/k

65. A string vibrates according to the equation $y = 5\sin\left(\frac{2\pi x}{3}\right)\cos 20\pi t$, **where x and y are in cm and t in sec. The distance between two adjacent nodes is**

(a) 3 cm (b) 4.5 cm

(c) 6 cm (d) 1.5 cm

Key

1	**a**	2	**a**	3	**a**	4	**b**	5	**b**	6	**c**	7	**c**	8	**b**	9	**a**	10	**a**
11	**a**	12	**a**	13	**a**	14	**d**	15	**c**	16	**a**	17	**c**	18	**c**	19	**b**	20	**b**
21	**d**	22	**c**	23	**b**	24	**d**	25	**b**	26	**c**	27	**d**	28	**c**	29	**b**	30	**b**
31	**d**	32	**a**	33	**a**	34	**b**	35	**b**	36	**d**	37	**b**	38	**c**	39	**a**	40	**b**
41	**a**	42	**d**	43	**a**	44	**b**	45	**b**	46	**b**	47	**b**	48	**d**	49	**b**	50	**c**
51	**b**	52	**a**	53	**a**	54	**b**	55	**a**	56	**b**	57	**b**	58	**a**	59	**a**	60	**a**
61	**a**	62	**a**	63	**a**	64	**d**	65	**d**										

Hints

1. (a) $v_{max} = a\omega = a \times 2\pi n = 0.1 \times 2\pi \times 300 = 60\pi\ cm / sec$

2. (a) $t = \frac{T}{4} = \frac{1}{4n} \Rightarrow n = \frac{1}{4t} = \frac{1}{4 \times 0.170} = 1.47\ Hz$

3. (a) $t_1 = \sqrt{\left(\frac{2h}{g}\right)} = \sqrt{\left(\frac{2 \times 500}{10}\right)} = 10\, sec$ and $t_2 = \frac{h}{v} = \frac{500}{340} \approx 1.5\, \text{sec}$

Total time $= t_1 + t_2 = 10 + 1.5 = 11.5\, \text{sec}$.

5. $n = \frac{3600}{2 \times 60} Hz \Rightarrow \lambda = \frac{v}{n} = \frac{760}{30} = 25.3$ m.

6. $v \propto \sqrt{T} \Rightarrow \sqrt{\frac{T_2}{T_1}} = \frac{v_2}{v_1} \Rightarrow T_2 = T_1 \left(\frac{v_2}{v_1}\right)^2 \Rightarrow T_2 = 273 \times 4 = 1092\, K$

7. $\bar{n} = \frac{1}{\lambda} = \frac{1}{6000 \times 10^{-10}} = 1.66 \times 10^{6} m^{-1}$

8. $v \propto \frac{1}{\sqrt{M}} \Rightarrow \frac{v_{H_2}}{v_{O_2}} = \sqrt{\frac{M_{O_2}}{M_{H_2}}} = \sqrt{\frac{32}{2}} \Rightarrow \frac{v_{H_2}}{v_{O_2}} = \frac{4}{1}$

10. $v_{sound} \propto \frac{1}{\sqrt{\rho}} \Rightarrow \frac{v_1}{v_2} = \sqrt{\frac{\rho_2}{\rho_1}} = \sqrt{\frac{4}{1}} = 2 \Rightarrow v_2 = \frac{v_1}{2} = \frac{v_s}{2}$

11. $t = \frac{d}{v}$ and $v \propto \sqrt{T} \Rightarrow \frac{t_1}{t_2} = \frac{v_2}{v_1} = \sqrt{\frac{T_2}{T_1}}$

$\Rightarrow \frac{2}{t_2} = \sqrt{\frac{303}{283}} \Rightarrow t_2 = 1.9$ sec.

13. $t = \frac{2d_1}{v} + \frac{2d_2}{v} \Rightarrow t = \frac{2}{v}(d_1 + d_2)$

$\Rightarrow (d_1 + d_2) = \frac{v \times t}{2} = \frac{340 \times 2}{2}$ =340 m.

23. Path difference $= \frac{\lambda}{2\pi} \times \varphi = \frac{\lambda}{2\pi} \times \frac{\pi}{3} = \frac{\lambda}{6} = \frac{v}{6n} = \frac{360}{6 \times 500} = 0.12\,m = 12\,cm$

33. $k = \frac{2\pi}{\lambda} = 0.01\pi \Rightarrow \lambda = 200$ m.

35. $y = a \sin 2\pi\left[\frac{t}{T} - \frac{x}{\lambda}\right] \Rightarrow \lambda = 40\ cm$

36. $v = \frac{\omega}{k} = \frac{2}{0.01} = 200\ cm/\sec$.

39. $v = \frac{\omega}{k} = \frac{7\pi}{0.4\pi} = 17.5\ m/s$

40. $\frac{I_1}{I_2} = \frac{a_1^2}{a_2^2} \Rightarrow \frac{I_1}{I_2} = \frac{25}{100} = \frac{1}{4}$

43. $\omega = 3000\ \pi \Rightarrow n = \frac{\omega}{2\pi} = 1500\ Hz$

and $k = \frac{2\pi}{\lambda} = 12\pi \Rightarrow \lambda = \frac{1}{6} m$

, $v = n\lambda \Rightarrow v = 1500 \times \frac{1}{6} = 250\ m/s$

46. $v = \frac{\omega}{k} = \frac{600}{2} = 300\,m/\sec$.

49. $y_1 = 10^{-6} \sin[100\ t + (x/50) + 0.5]$

$y_2 = 10^{-6} \sin\left[100\ t + \left(\frac{x}{50}\right) + \left(\frac{\pi}{2}\right)\right]$

$\phi = [100t + (x/50) + 1.57] - [100t + (x/50) + 0.5]$

$= 1.07$ radians.

54. $\frac{I_{max}}{I_{min}} = \frac{\left(\frac{\sqrt{I_1}}{\sqrt{I_2}} + 1\right)^2}{\left(\frac{\sqrt{I_1}}{\sqrt{I_2}} - 1\right)^2} = \frac{\left(\sqrt{\frac{9}{1}} + 1\right)^2}{\left(\sqrt{\frac{9}{1}} - 1\right)^2} = \frac{4}{1}$

55. $\phi = \frac{\pi}{2} \Rightarrow A = \sqrt{a_1^2 + a_2^2} = \sqrt{(4)^2 + (3)^2} = 5$

65. $y = 5\sin\left(\frac{2\pi x}{3}\right)\cos 20\pi t,$

$$y = 2a\sin\frac{2\pi x}{\lambda}\cos\frac{2\pi vt}{\lambda} \Rightarrow \lambda = 3,$$

Require distance $= \lambda/2 = 1.5\,cm$.

Beats

1. **A tuning fork arrangement (pair) produces 4 beats/ sec with one fork of frequency 288 cps. A little wax is placed on the unknown fork and it then produces 2 beats/ sec. The frequency of the unknown fork is**

   (a) 286 cps (b) 292 cps

   (c) 294 cps (d) 288 cps

2. **A tuning fork vibrates with 2 beats in 0.04 second. The frequency of the fork is**

   (a) 50 Hz (b) 100 Hz

   (c) 80 Hz (d) None of these

3. **Two sound sources when sounded simultaneously produce four beats in 0.25 second. the difference in their frequencies must be**

   (a) 4 (b) 8

   (c) 16 (d) 1

4. **A tuning fork of known frequency 256 Hz makes 5 beats per second with the vibrating string of a piano. The beat frequency decreases to 2 beats per second when the tension in the piano string is slightly increased. The frequency of the piano string before increasing the tension was**

   (a) 256 + 5 Hz (b) 256 + 2Hz

   (c) 256 – 2 Hz (d) 256 – 5Hz

5. **When temperature increases, the frequency of a tuning fork**

   (a) Increases

   (b) Decreases

   (c) Remains same

   (d) Increases or decreases depending on the material

6. Two strings X and Y of a sitar produce a beat frequency 4 Hz. When the tension of the string Y is slightly increased the beat frequency is found to be 2 Hz. If the frequency of X is 300 Hz, then the original frequency of Y was

(a) 296 Hz (b) 298 Hz

(c) 302 Hz (d) 304 Hz

7. The frequency of tuning forks A and B are respectively 3% more and 2% less than the frequency of tuning fork C. When A and B are simultaneously excited, 5 beats per second are produced. Then the frequency of the tuning fork 'A' (in Hz) is

(a) 98 (b) 100

(c) 103 (d) 105

8. When a tuning fork vibrates, the waves produced in the fork are

(a) Longitudinal (b) Transverse

(c) Progressive (d) Stationary

9. Two vibrating tuning forks produce progressive waves given by $Y_1 = 4\sin 500\pi t$ **and** $Y_2 = 2\sin 506\pi t$. **Number of beats produced per minute is**

(a) 360 (b) 180

(c) 3 (d) 60

10. When a tuning fork produces sound waves in air, which one of the following is same in the material of tuning fork as well as in air

(a) Wavelength (b) Frequency

(c) Velocity (d) Amplitude

11. The disc of a siren containing 60 holes rotates at a constant speed of 360 rpm. The emitted sound is in unison with a tuning fork of frequency

(a) 10 Hz (b) 360 Hz

(c) 216 Hz (d) 6 Hz

12. A sound source of frequency 170 Hz is placed near a wall. A man walking from a source towards the wall finds that there is a periodic rise and fall of sound intensity. If the speed of sound in air is 340 m/s the distance (in metres) separating the two adjacent positions of minimum intensity is

(a) 1/2 (b) 1

(c) 3/2 (d) 23

Key

1	**b**	2	**a**	3	**c**	4	**d**	5	**b**	6	**a**	7	**c**	8	**a**	9	**b**	10	**b**
11	**b**	12	**b**																

Hints

3. Number of beats = $\frac{4}{0.25} = 16$

7. $n_A = n + \frac{3n}{100} = \frac{103n}{100}$ and $n_B = n - \frac{2n}{100} = \frac{98}{100}$

$n_A - n_B = 5 \Rightarrow \frac{5n}{100} = 5 \Rightarrow n = 100\ Hz$

$\therefore n_A = \frac{(103)(100)}{100} = 103\ Hz$

12. $v = n\lambda \Rightarrow \lambda = \frac{v}{n} = \frac{340}{170} \Rightarrow \lambda = 2$

Required distance = $\frac{\lambda}{2} = \frac{2}{2} = 1$ m

Vibration of String

1. **A tuning fork vibrating with a sonometer having 20 cm wire produces 5 beats per second. The beat frequency does not change if the length of the wire is changed to 21 cm. the frequency of the tuning fork (in Hertz) must be**

(a)200 (b) 210

(c) 205 (d) 215

2. **A stretched string of length l, fixed at both ends can sustain stationary waves of wavelength λ, given by**

(a) $\lambda = \frac{n^2}{2l}$ (b) $\lambda = \frac{l^2}{2n}$

(c) $\lambda = \frac{2l}{n}$ (d) $\lambda = 2l\,n$

3. **A second harmonic has to be generated in a string of length l stretched between two rigid supports. The point where the string has to be plucked and touched are**

(a) Plucked at $\frac{l}{4}$ and touch at $\frac{l}{2}$

(b) Plucked at $\frac{l}{4}$ and touch at $\frac{3l}{4}$

(c) Plucked at $\frac{l}{2}$ and touched at $\frac{l}{4}$

(d) Plucked at $\frac{l}{2}$ and touched at $\frac{3l}{4}$

4. **Transverse waves of same frequency are generated in two steel wires A and B. The diameter of A is twice of B and the tension in A is half that in B. The ratio of velocities of wave in A and B is**

(a) $1:3\sqrt{2}$ (b) $1:2\sqrt{2}$

(c) $1:2$ (d) $\sqrt{2}:1$

5. A sonometer wire resonates with a given tuning fork forming standing waves with five antinodes between the two bridges when a mass of 9 kg is suspended from the wire. When this mass is replaced by a mass M, the wire resonates with the same tuning fork forming three antinodes for the same positions of the bridges. The value of M is

(a) 25 kg (b) 5 kg

(c) 12.5 kg (d) 1/25 kg

6. The tension of a stretched string is increased by 69%. In order to keep its frequency of vibration constant, its length must be increased by

(a) 20% (b) 30%

(c) $\sqrt{69}\%$ (d) 69%

7. A string in musical instrument is 50 cm long and its fundamental frequency is 800 Hz. If a frequency of 1000 Hz is to be produced, then required length of string is

(a) 62.5 cm (b) 50 cm

(c) 40 cm (d) 37.5 cm

8. Two wires are in unison. If the tension in one of the wires is increased by 2%, 5 beats are produced per second. The initial frequency of each wire is

(a) 200 Hz (b) 400 Hz

(c) 500 Hz (d) 1000 Hz

9. Two uniform strings A and B made of steel are made to vibrate under the same tension. if the first overtone of A is equal to the second overtone of B and if the radius of A is twice that of B, the ratio of the lengths of the strings is

(a) 1: 2 (b) 1 : 3

(c) 1 : 4 (d) 1 : 6

10. If the length of a stretched string is shortened by 40% and the tension is increased by 44%, then the ratio of the final and initial fundamental frequencies is

(a) 2 : 1 (b) 3 : 2

(c) 3 : 4 (d) 1 : 3

11. Two wires are fixed in a sonometer. Their tensions are in the ratio 8: 1. The lengths are in the ratio $36:35$. **The diameters are in the ratio 4: 1. Densities of the materials are in the ratio 1: 2. If the lower frequency in the setting is 360 Hz. the beat frequency when the two wires are sounded together is**

(a)5 (b) 8

(c) 6 (d) 10

12. The first overtone of a stretched wire of given length is 320 Hz. The first harmonic is

(a) 320 Hz (b) 160 Hz

(c) 480 Hz (d) 640 Hz

13. Two perfectly identical wires are in unison. When the tension in one wire is increased by 1%, then on sounding them together 3 beats are heard in 2 sec. The initial frequency of each wire is

(a) $220\ s^{-1}$ (b) $320\ s^{-1}$

(c) $150\ s^{-1}$ (d) $300\ s^{-1}$

14. A tuning fork of frequency 392 Hz resonates with 50 cm length of a string under tension (T). If length of the string is decreased by 2%, keeping the tension constant, the number of beats heard when the string and the tuning fork made to vibrate simultaneously is

(a) 4 (b) 6

(c) 8 (d) 12

15. The sound carried by air from a sitar to a listener is a wave of the following type

(a) Longitudinal Stationary (b) Transverse Progressive

(c) Transverse Stationary (d) Longitudinal Progressive

16. In Melde's experiment in the transverse mode, the frequency of the tuning fork and the frequency of the waves in the strings are in the ratio

(a) 1 : 1 (b) 1 : 2

(c) 2 : 1 (d) 4 : 1

17. The frequency of transverse vibrations in a stretched string is 200 Hz. If the tension is increased four times and the length is reduced to one-fourth the original value, the frequency of vibration will be

(a) 25 Hz (b) 200 Hz

(c) 400 Hz (d) 1600 Hz

18. The fundamental frequency of a sonometer wire is n. If its radius is doubled and its tension becomes half, the material of the wire remains same, the new fundamental frequency will be

(a) n (b) $\frac{n}{\sqrt{2}}$

(c) $\frac{n}{2}$ (d) $\frac{n}{2\sqrt{2}}$

19. In an experiment with sonometer a tuning fork of frequency 256 Hz resonates with a length of 25 cm and another tuning fork resonates with a length of 16 cm. Tension of the string remaining constant the frequency of the second tuning fork is

(a) 163.84 Hz (b) 400 Hz

(c) 320 Hz (d) 204.8 Hz

Key

1	**c**	2	**c**	3	**a**	4	**b**	5	**a**	6	**b**	7	**c**	8	**c**	9	**b**	10	**a**
11	**d**	12	**b**	13	**d**	14	**c**	15	**d**	16	**a**	17	**d**	18	**d**	19	**b**		

Hints

1. $n_1 l_1 = n_2 l_2 \Rightarrow (N+5)\times 20 = (N-5)\times 21 \Rightarrow N = 205\ Hz$.

4. $v = \sqrt{\frac{T}{m}} = \sqrt{\frac{T}{\pi r^2 \rho}}$

$\frac{v_A}{v_B} = \frac{r_B}{r_A}\sqrt{\frac{T_A}{T_B}} = \frac{1}{2\sqrt{2}}$

5. $n_1 = \frac{5}{2l}\sqrt{\frac{9g}{m}}$ and $n_2 = \frac{3}{2l}\sqrt{\frac{Mg}{m}}$

$\because$ $n_1 = n_2 \Rightarrow \frac{5}{2l}\sqrt{\frac{9g}{m}} = \frac{3}{2l}\sqrt{\frac{Mg}{m}} \Rightarrow M = 25$ kg.

7. $n_1 l_1 = n_2 l_2 \Rightarrow 800\times 50 = 1000\times l_2 \Rightarrow l_2 = 40\ cm$

8. $\frac{\Delta n}{n} = \frac{\Delta T}{2T}$

$n = 500\ Hz$.

9. $2\left[\frac{1}{2l_A r_A}\sqrt{\frac{T}{\pi\rho}}\right] = 3\left[\frac{1}{2l_B r_B}\sqrt{\frac{T}{\pi\rho}}\right]$

$\frac{l_A}{l_B} = \frac{2}{3}\frac{r_B}{r_A} \Rightarrow \frac{l_A}{l_B} = \frac{2}{3}\times\frac{r_B}{(2r_B)} = \frac{1}{3}$

10. $n = \frac{1}{2l}\sqrt{\frac{T}{m}} \Rightarrow n \propto \frac{\sqrt{T}}{l}$

$\frac{n'}{n} = \frac{2}{1}$.

11. $\frac{n_1}{n_2} = \frac{l_2}{l_1}\sqrt{\frac{T_1}{T_2}\times\left(\frac{d_2}{d_1}\right)^2\times\left(\frac{\rho_2}{\rho_1}\right)} \Rightarrow n_2 = \frac{36}{35}\times 360 = 370$

Beat frequency = $n_2 - n_1 = 10$

14. $n \propto \frac{1}{l} \Rightarrow \frac{\Delta n}{n} = -\frac{\Delta l}{l}$

$n_2 - n_1 = \frac{2}{100} \times n_1 = \frac{2}{100} \times 392 = 7.8 \approx 8.$

17. $n = \frac{1}{2l}\sqrt{\frac{T}{m}} \Rightarrow \frac{n_1}{n_2} = \frac{l_2}{l_1}\sqrt{\frac{T_1}{T_2}} = \frac{1}{4}\sqrt{\frac{1}{4}} = \frac{1}{8}$

$\Rightarrow n_2 = 8n_1 = 8 \times 200 = 1600\,Hz$

18. $n = \frac{1}{2l}\sqrt{\frac{T}{\pi r^2 \rho}} \Rightarrow n \propto \frac{\sqrt{T}}{r}$

$\Rightarrow \frac{n_2}{n_1} = \frac{r_1}{r_2}\sqrt{\frac{T_2}{T_1}} = \frac{1}{2} \times \sqrt{\frac{1}{2}} = \frac{1}{2\sqrt{2}}$

19. $n = \frac{p}{2l}\sqrt{\frac{T}{m}} \Rightarrow \frac{n_2}{n_1} = \frac{l_1}{l_2} \Rightarrow n_2 = \frac{25}{16} \times 256 = 400 \quad Hz$

Organ Pipes

1. A cylindrical tube, open at both ends, has a fundamental frequency f_0 in air. The tube is dipped vertically into water such that half of its length is inside water. The fundamental frequency of the air column now is

(a) $3f_0/4$ (b) f_0

(c) $f_0/2$ (d) $2f_0$

2. If the length of a closed organ pipe is 1.5 m and velocity of sound is 330 m/s, then the frequency for the second note is

(a) 220 Hz (b) 165 Hz

(c) 110 Hz (d) 55 Hz

3. A pipe 30 cm long is open at both ends. Which harmonic mode of the pipe is resonantly excited by a 1.1 kHz source? (Take speed of sound in air = 330 ms^{-1})

(a) First (b) Second

(c) Third (d) Fourth

4. Two closed organ pipes, when sounded simultaneously gave 4 beats per sec. If longer pipe has a length of 1m. Then length of shorter pipe will be, (v = 300 m/s)

(a)185.5 cm (b) 94.9 cm

(c) 90 cm (d) 80 cm

5. A source of sound placed at the open end of a resonance column sends an acoustic wave of pressure amplitude ρ_0 inside the tube. If the atmospheric pressure is ρ_A, then the ratio of maximum and minimum pressure at the closed end of the tube will be

(a) $\frac{(\rho_A + \rho_0)}{(\rho_A - \rho_0)}$ (b) $\frac{(\rho_A + 2\rho_0)}{(\rho_A - 2\rho_0)}$

(c) $\frac{\rho_A}{\rho_A}$ (d) $\frac{\left(\rho_A + \frac{1}{2}\rho_0\right)}{\left(\rho_A - \frac{1}{2}\rho_0\right)}$

6. Two closed pipe produce 10 beats per second when emitting their fundamental nodes. If their length are in ratio of 25: 26. Then their fundamental frequency in Hz, are

(a) 270, 280 (b) 260, 270

(c) 260, 250 (d) 260, 280

7. A closed organ pipe and an open organ pipe are tuned to the same fundamental frequency. What is the ratio of lengths

(a)1 : 2 (b) 2 : 1

(c) 2 : 3 (d) 4 : 3

8. An open pipe resonates with a tuning fork of frequency 500 Hz. it is observed that two successive nodes are formed at distances 16 and 46 cm from the open end. The speed of sound in air in the pipe is

(a) 230 m/s (b) 300 m/s

(c) 320 m/s (d) 360 m/s

9. Find the fundamental frequency of a closed pipe, if the length of the air column is 42 m. (speed of sound in air = 332 m/sec)

(a) 2 Hz (b) 4 Hz

(c) 7 Hz (d) 9 Hz

10. If v is the speed of sound in air then the shortest length of the closed pipe which resonates to a frequency n

(a) $\frac{v}{4n}$ (b) $\frac{v}{2n}$

(c) $\frac{2n}{v}$ (d) $\frac{4n}{v}$

11. The frequency of fundamental tone in an open organ pipe of length 0.48 m is 320 Hz. Speed of sound is 320 m/sec. Frequency of fundamental tone in closed organ pipe will be

(a) 153.8 Hz (b) 160.0 Hz

(c) 320.0 Hz (d) 143.2 Hz

12. If fundamental frequency of closed pipe is 50 Hz then frequency of 2^{nd} overtone is

(a)100 Hz (b) 50 Hz

(c) 250 Hz (d) 150 Hz

13. Two open organ pipes of length 25 cm and 25.5 cm produce 10 beat/ sec. The velocity of sound will be

(a) 255 m/s (b) 250 m/s

(c) 350 m/s (d) None of these

14. What is minimum length of a tube, open at both ends, that resonates with tuning fork of frequency 350 Hz? [velocity of sound in air = 350 m/s]

(a) 50 cm (b) 100 cm

(c) 75 cm (d) 25 cm

15. Two open organ pipes give 4 beats/ sec when sounded together in their fundamental nodes. If the length of the pipe are 100 cm and 102.5 cm respectively, then the velocity of sound is

(a) 496 m/s (b) 328 m/s

(c) 240 m/s (d) 160 m/s

16. The harmonics which are present in a pipe open at one end are

(a) Odd harmonics

(b) Even harmonics

(c) Even as well as odd harmonics

(c) None of these

17. An open pipe is suddenly closed at one end with the result that the frequency of third harmonic of the closed pipe is found to be higher by 100 Hz, then the fundamental frequency of open pipe is:

(a) 480 Hz (b) 300 Hz

(c) 240 Hz (d) 200 Hz

18. Tube A has both ends open while tube B has one end closed, otherwise they are identical. The ratio of fundamental frequency of tube A and B is

(a) 1 : 2 (b) 1 : 4

(c) 2 : 1 (d) 4 : 1

19. If the temperature increases, then what happens to the frequency of the sound produced by the organ pipe

(a) Increases (b) Decreases

(c) Unchanged (d) Not definite

20. Apparatus used to find out the velocity of sound in gas is

(a) Melde's apparatus (b) Kundt's tube

(c) Quincke's tube (d) None of these

21. In one meter long open pipe what is the harmonic of resonance obtained with a tuning fork of frequency 480 Hz

(a) First (b) Second

(c) Third (d) Fourth

22. An organ pipe open at one end is vibrating in first overtone and is in resonance with another pipe open at both ends and vibrating in third harmonic. The ratio of length of two pipes is

(a) 1 : 2 (b) 4 : 1

(c) 8 : 3 (d) 3 : 8

23. In a resonance pipe the first and second resonances are obtained at depths 22.7 cm and 70.2 cm respectively. What will be the end correction

(a) 1.05 cm (b) 115.5 cm

(c) 92.5 cm (d) 113.5 cm

24. An open tube is in resonance with string (frequency of vibration of tube is n_0). If tube is dipped in water so that 75% of length of tube is inside water, then the ratio of the frequency of tube to string now will be

(a) 1 (b) 2

(c) $\frac{2}{3}$ (d) $\frac{3}{2}$

Key

1	**b**	2	**b**	3	**a**	4	**b**	5	**a**	6	**c**	7	**a**	8	**b**	9	**a**	10	**a**
11	**b**	12	**c**	13	**a**	14	**a**	15	**b**	16	**a**	17	**d**	18	**c**	19	**a**	20	**b**
21	**c**	22	**a**	23	**a**	24	**b**												

Hints

2. n = $\frac{3v}{4l} = \frac{3 \times 330}{4 \times 1.5} = 165\ Hz$.

3. $n_1 = \frac{v}{2l} = \frac{330}{2 \times 0.3} = 550\ Hz$

n = $2 \times n_1 = 1100\ Hz$. = $1.1\ kHz$

4. $n_1 = \frac{v}{4l_1}$ and $n_2 = \frac{v}{4l_2}$

Number of beats = $n_2 - n_1 = 4$

$\Rightarrow 4 = \frac{v}{4}\left(\frac{1}{l_2} - \frac{1}{l_1}\right) \Rightarrow 16 = 300\left(\frac{1}{l_2} - \frac{1}{1}\right) \Rightarrow l_2 = 94.9\ cm$

6. $n_1 - n_2 = 10$

$n_1 = \frac{v}{4l_1}$ and $n_2 = \frac{v}{4l_2}$

$\Rightarrow \frac{n_1}{n_2} = \frac{l_2}{l_1} = \frac{26}{25}$

$n_1 = 260\,Hz$, $n_2 = 250\ Hz$

8. Distance between two consecutive nodes $= \frac{\lambda}{2} = 46 - 16 = 30 \Rightarrow \lambda = 60$ cm = 0.6m

$\therefore\ v = n\lambda = 500 \times 0.6 = 300\ m/s$.

9. $n = \frac{v}{4l} \Rightarrow n = \frac{332}{4 \times 42} = 2\,Hz$

12. $n_3 = 5n_1 = 5 \times 50 = 250\ Hz$

13. (a) $\Delta n = n_1 - n_2 \Rightarrow 10 = \frac{v}{2l_1} - \frac{v}{2l_2} = \frac{v}{2}\left[\frac{1}{l_1} - \frac{1}{l_2}\right]$

$\Rightarrow 10 = \frac{v}{2}\left[\frac{1}{0.25} - \frac{1}{0.255}\right] \Rightarrow v = 255\ m/s.$

14. $n = \frac{v}{2l} \Rightarrow 350 = \frac{350}{2l} \Rightarrow l = \frac{1}{2}m = 50\ cm.$

15. (b) $\Delta n = n_1 - n_2 \Rightarrow 4 = \frac{v}{2l_1} - \frac{v}{2l_2} = \frac{v}{2}\left[\frac{1}{1.00} - \frac{1}{1.025}\right]$

$V = \frac{8}{0.025} \approx 328\,m/s.$

21. $N = \frac{n \times 2l}{v} = \frac{480}{330} \times 2 \times 1 = 3$

23. $\frac{l_2 + x}{l_1 + x} = \frac{3\lambda / 4}{\lambda / 4} = 3$

$$x = \frac{l_2 - 3l_1}{2} = \frac{70.2 - 3 \times 22.7}{2} = 1.05\ cm$$

24. $n_0 = \frac{v}{2l}$

$$l' = l \times \frac{25}{100} = \frac{l}{4}$$

$$n = \frac{v}{4l'} = \frac{v}{4 \times (l/4)} = \frac{v}{l} = 2n_0 \Rightarrow \frac{n}{n_0} = 2$$

Doppler's Effect

1. **A sound source is moving towards a stationary observer with 1/10 of the speed of sound. The ratio of apparent to real frequency is**

   (a) 10/9 (b) 11/10

   (c) $(11/10)^2$ (d) $(9/10)^2$

2. **A siren emitting sound of frequency 500 Hz is going away from a static listener with a speed of 50 m/sec. The frequency of sound to be heard, directly from the siren is**

   (a) 434.2 Hz (b) 589.3 Hz

   (c) 481.2 Hz (d) 286.5 Hz

3. **A source is moving towards an observer with a speed of 20 m/s and having frequency of 240 Hz. The observer is now moving towards the source with a speed of 20 m/s. Apparent frequency heard by observer, if velocity of sound is 340 m/s is**

   (a) 240 Hz (b) 270 Hz

   (c) 280 Hz (d) 360 Hz

4. **A siren placed at a railway platform is emitting sound of frequency 5 kHz. A passenger sitting in a moving train A records a frequency of 5.5 kHz while the train approaches the siren. During his return journey in a different train B he records a frequency of 6.0 kHz while approaching the same siren. The ratio of the velocity of train B to that of train A is**

   (a) 242/252 (b) 2

   (c) 5/6 (d) 11/6

5. **A whistle revolves in a circle with an angular speed of 20 rad/sec using a string of length 50 cm. If the frequency of sound from the whistle is 385 Hz, then what is the minimum frequency heard by an observer, which is far away from the centre in the same plane ? (v = 340 m/s)**

(a) 333 Hz (b) 374 Hz

(c) 385 Hz (d) 394 Hz

6. **A Siren emitting sound of frequency 800 Hz is going away from a static listener with a speed of 30 m/s, frequency of the sound to be heard by the listener is (take velocity of sound as 330 m/s)**

(a) 733.3 Hz (b) 644.8 Hz

(c) 481.2 Hz (d) 286.5 Hz

7. **A car sounding a horn of frequency 1000 Hz passes an observer. The ratio of frequencies of the horn noted by the observer before and after passing of the car is 11: 9. If the speed of sound is v, the speed of the car is**

(a) $\frac{1}{10}v$ (b) $\frac{1}{2}v$

(c) $\frac{1}{5}v$ (d) v

8. **What should be the velocity of a sound source moving towards a stationary observer so that apparent frequency is double the actual frequency (Velocity of sound is v)?**

(a) v (b) 2v

(c) $\frac{v}{2}$ (d) $\frac{v}{4}$

9. **Two trains are moving towards each other at speeds of 20 m/s and 15 m/s relative to the ground. The first train sounds a whistle of frequency 600 Hz. the frequency of the whistle heard by a passenger in the second train before the train meets is (the speed of sound in air is 340 m/s)**

(a) 600 Hz (b) 585 Hz

(c) 645 Hz (d) 666 Hz

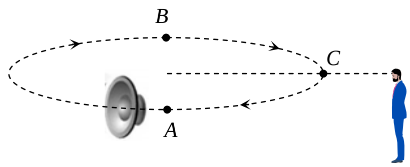
10. A small source of sound moves on a circle as shown in the figure and an observer is standing on O. Let n_1, n_2 and n_3 be the frequencies heard when the source is at A, B and C respectively. Then

(a) $n_1 > n_2 > n_3$

(b) $n_2 > n_3 > n_1$

(c) $n_1 = n_2 > n_3$

(d) $n_2 > n_1 > n_3$



11. A source and an observer approach each other with same velocity 50 m/s. If the apparent frequency is 435 sec^{-1}, then the real frequency is

(a) 320 s^{-1} (b) 360 sec^{-1}

(c) 390 sec^{-1} (d) 420 sec^{-1}

12. A source emits a sound of frequency of 400 Hz, but the listener hears it to be 390 Hz. Then

(a) The listener is moving towards the source.

(b) The source is moving towards the listener.

(c) The listener is moving away from the source.

(d) The listener has a defective ear.

13. Doppler effect is applicable for

(a) Moving bodies

(b) One is moving and other is stationary

(c) For relative motion

(d) None of these

14. A source and an observer are moving towards each other with a speed equal to $\frac{v}{2}$ where v is the speed of sound. The source is emitting sound of frequency n. The frequency heard by the observer will be

(a) Zero (b) n

(c) $\frac{n}{3}$ (d) $3n$

15. When an engine passes near to a stationary observer then its apparent frequencies occurs in the ratio 5/3. If the velocity of engine is

(a) 540 m/s (b) 270 m/s

(c) 85 m/s (d) 52.5 m/s

16. A police car horn emits a sound at a frequency 240 Hz when the car is at rest. If the speed of the sound is 330 m/s, the frequency heard by an observer who is approaching the car at a speed of 11 m/s, is :

(a) 248 Hz (b) 244 Hz

(c) 240 Hz (d) 230 Hz

17. A person carrying a whistle emitting continuously a note of 272 Hz is running towards a reflecting surface with a speed of 18 km/hour. The speed of sound in air is $345\,ms^{-1}$. The number of beats heard by him is

(a)4 (b) 6

(c) 8 (d) 3

18. A bus is moving with a velocity of 5 m/s towards a huge wall. The driver sounds a horn of frequency 165 Hz. If the speed of sound in air is 355 m/s, the number of beats heard per second by a passenger on the bus will be

(a)6 (b) 5

(c) 3 (d) 4

19. A source of sound of frequency 256 Hz is moving rapidly towards a wall with a velocity of 5m/s. The speed of sound is 330 m/s. If the observer is between the wall and the source, then beats per second heard will be

(a)7.8 Hz (b) 7.7 Hz

(c) 3.9 Hz (d) Zero

20. The apparent frequency of a note, when a listener moves towards a stationary source, with velocity of 40 m/s is 200 Hz. When he moves away from the same source with the same speed, the apparent frequency of the same note is 160 Hz. The velocity of sound in air is (in m/s)

(a) 360 (b) 330

(c) 320 (d) 340

21. An observer moves towards a stationary source of sound, with a velocity one-fifth of the velocity of sound. What is the percentage increase in the apparent frequency

(a) 5% (b) 20%

(c) Zero (d) 0.5%

Key

1	**a**	2	**a**	3	**b**	4	**b**	5	**b**	6	**a**	7	**a**	8	**c**	9	**d**	10	**b**
11	**a**	12	**c**	13	**c**	14	**d**	15	**c**	16	**a**	17	**c**	18	**b**	19	**a**	20	**a**
21	**b**																		

Hints

1. $n' = n\left(\frac{v}{v - v_S}\right) = n\left(\frac{v}{v - v/10}\right) \Rightarrow \frac{n'}{n} = \frac{10}{9}$

2. $\left(n' = n\left(\frac{v}{v + v_S}\right) = 500 \times \left(\frac{330}{300 + 50}\right) = 434.2\,Hz\right.$

3. $\left(n' = n\left(\frac{v+v_O}{v-v_S}\right) = 240\left(\frac{340+20}{340-20}\right) = 270\ Hz\right.$

4. $n' = n\left(\frac{v+v_0}{v}\right)$

$$5.5 = 5\left(\frac{v+v_A}{v}\right) \quad \text{and} \quad 6 = 5\left(\frac{v+v_B}{v}\right)$$

$\frac{v_B}{v_A} = 2$

5. $n_{\min} = n\left(\frac{v}{v+v_s}\right)$ where $v = r\omega = 0.5 \times 10 = 1\, m/s$

$\Rightarrow n_{\min} = 385\left(\frac{340}{340+10}\right) = 374\ Hz.$

6. $n' = n\left(\frac{v}{v+v_S}\right) = 800\left(\frac{330}{330+30}\right) = 733.33\ Hz$

7. $n_{Before} = \frac{v}{v-v_c} n$ and $n_{After} = \frac{v}{v+v_c}.n$

$\frac{n_{Before}}{n_{After}} = \frac{11}{9} = \left(\frac{v+v_c}{v-v_c}\right) \Rightarrow v_c \Rightarrow \frac{v}{10}$

9. $n' = n\left(\frac{v+v_0}{v-v_s}\right) = 600\left(\frac{340+15}{340-20}\right) \approx 666\ Hz$

11. $n' = n\left[\frac{v+v_O}{v-v_S}\right] \qquad \Rightarrow 435 = n\left[\frac{332+50}{332-50}\right] \Rightarrow n = 321.12\ sec^{-1} \approx 320\ sec^{1}$

15. $n' = n\left(\frac{v}{v-v_S}\right)$ and $n'' = \left(\frac{v}{v+v_S}\right)n$

$\therefore \frac{n'}{n''} = \frac{v+v_S}{v-v_S} \Rightarrow \frac{5}{3} = \frac{340+v_S}{340-v_S} \Rightarrow v_S = 85\ m/s.$

16. $n' = n\left(\frac{v+v_0}{v}\right) = 240\left(\frac{330+11}{330}\right) = 248\ Hz.$

17. $n' = \frac{v + v_{\text{person}}}{v - v_{\text{person}}}.272 = \frac{345+5}{345-5} \times 272 = 280$ Hz

Number of beats =280 – 272 = 8 Hz

18. $n' = \frac{v + v_B}{v - v_B} \times n = \frac{355+5}{355-5} \times 165 = 170$ Hz

x $= n' - n = 170 - 165 = 5$

21. $n' = \left[\frac{v + v_O}{v}\right] n = \left[\frac{v + v/5}{v}\right] n = \frac{6}{5} n = 1.2n$

Percentage change = $\frac{0.2n}{n} \times 100$ = 20%.