Wave Motion

1. **Ultrasonic, Infrasonic and audible waves travel through a medium with speeds V_u, V_i and V_a respectively, then**

(a) V_u, V_i and V_a are nearly equal

(b) $V_u \geq V_a \geq V_i$

(c) $V_u \leq V_a \leq V_i$

(d) $V_a \leq V_u$ and $V_u \approx V_i$

2. **The distance between two consecutive crests in a wave train produced in a string is 5 cm. If 2 complete waves pass through any point per second, the velocity of the wave is**

(a)10 cm/sec (b) 2.5 cm/sec

(c)5 cm/sec (d) 15 cm/sec

3. **A tuning fork makes 256 vibrations per second in air. When the velocity of sound is 330 m/s, then wavelength of the tone emitted is**

(a)0.56 m (b) 0.89 m

(c)1.11 m (d) 1.29 m

4. **A man sets his watch by a whistle that is 2 km away. How much will his watch be in error. (speed of sound in air 330 m/sec)**

(a)3 seconds fast (b) 3 seconds slow

(c)6 seconds fast (d) 6 seconds slow

5. 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

6. Sound waves have the following frequencies that are audible to human beings

(a)5 c/s (b) 27000 c/s

(c)5000 c/s (d) 50,000 c/s

7. Velocity of sound waves in air is 330 m/sec. For a particular sound in air, a path difference of 40 cm is equivalent to a phase difference of 1.6π. The frequency of this wave is

(a)165 Hz (b) 150 Hz

(c)660 Hz (d) 330 Hz

8. The wavelength of ultrasonic waves in air is of the order of

(a) $5\times10^{-5}\ cm$ (b) $5\times10^{-8}\ cm$

(c) $5\times10^{5}\ cm$ (d) $5\times10^{8}\ cm$

9. The relation between phase difference (Δϕ) and path difference (Δx) is

(a) $\Delta\phi = \frac{2\pi}{\lambda}\Delta x$ (b) $\Delta\phi = 2\pi\lambda\Delta x$

(c) $\Delta\phi = \frac{2\pi\lambda}{\Delta x}$ (d) $\Delta\phi = \frac{2\Delta x}{\lambda}$

10. A hospital uses an ultrasonic scanner to locate tumors in a tissue. The operating frequency of the scanner is 4.2 MHz. The speed of sound in a tissue is 1.7 km-s^{-1}. The wavelength of sound in the tissue is close to

(a) $4\times10^{-4}\ m$ (b) $8\times10^{-3}\ m$

(c) $4\times10^{-3}\ m$ (d) $8\times10^{-4}\ m$

11. Frequency range of the audible sounds is

(a)0 Hz – 30 Hz (b) 20 Hz – 20 kHz

(c)20 kHz – 20,000 kHz (d) 20 kHz – 20 MHz

12. In a medium sound travels 2 km in 3 sec and in air, it travels 3 km in 10 sec. The ratio of the wavelengths of sound in the two media is

(a)1 : 8 (b) 1 : 18

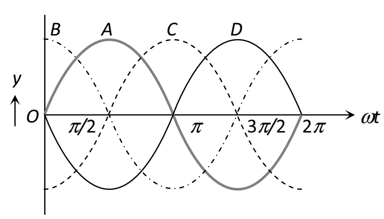
(c) 8 : 1 (d) 20 : 9

13. The waves in which the particles of the medium vibrate in a direction perpendicular to the direction of wave motion is known as

(a)Transverse wave (b) Longitudinal waves

(c)Propagated waves (d) None of these

14. The figure shows four progressive waves A, B, C, and D with their phases expressed with respect to the wave A. It can be concluded from the figure that



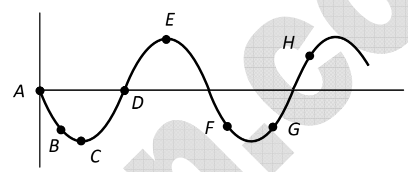
(a) The wave C is ahead by a phase angle of π/2 and the wave B lags behind by a phase angle of π /2

(b) The wave C lags behind by a phase angle of π/2 and the wave B is ahead by a phase angle of π /2

(c) The wave C is ahead by a phase angle of π and the wave B lags behind by a phase angle of π

(d) The wave C lags behind by a phase angle of π and the wave B ahead by a phase angle of π

15. The diagram below shows the propagation of a wave. Which points are in same phase



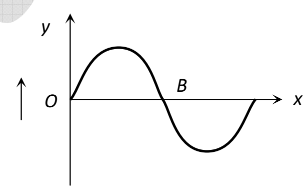
(a) F, G

(b) C and E

(c) B and G

(d) B and F

16. Fig. below shows the wave $y = A\sin(\omega t - kx)$ at any instant travelling in the +ve x-direction. What is the slope of the curve at B



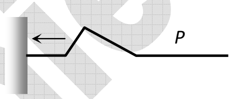
(a) ω / A

(b) k / A

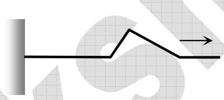
(c) kA

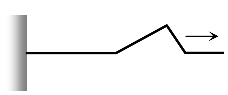
(d) ωA

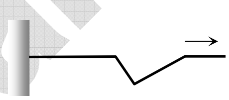
17. Figure here shows an incident pulse P reflected from a rigid support. Which one of A, B, C, D represents the reflected pulse

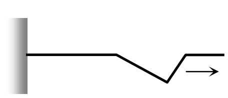


correctly

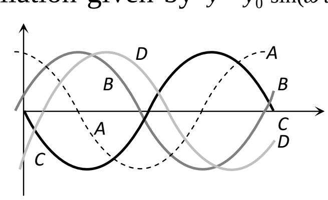
(a) 

(b) 

(c) 

(d) 

18. Which of the following curves represents correctly the oscillation given by $y = y_0 \sin(\omega t - \phi)$, where $0 < \phi < 90$



(a)A (b) B

(c)C (d) D

19. The equation of a wave is $y = 2\sin\pi(0.5x - 200t)$, where x and y are expressed in cm and t in sec. The wave velocity is

(a)100 cm/sec (b) 200 cm/sec

(c)300 cm/sec (d) 400 cm/sec

20. Equation of a progressive wave is given by $y = 0.2\cos\pi\left(0.04t + .02x - \frac{\pi}{6}\right)$

The distance is expressed in cm and time in second. What will be the minimum distance between two particles having the phase difference of π/2

(a) 4 cm (b) 8 cm

(c) 25 cm (d) 12.5 cm

21. A travelling wave passes a point of observation. At this point, the time interval between successive crests is 0.2 seconds an

(a) The wavelength is 5 m

(b) The frequency is 5 Hz

(c) The velocity of propagation is 5 m/s (d) The wavelength is 0.2 m

22. The equation of a wave travelling on a string is $y = 4\sin\frac{\pi}{2}\left(8t - \frac{x}{8}\right)$. If x and y are in cm, then velocity of wave is (a) 64 cm/sec in – x direction

(b) 32 cm/sec in – x direction

(c) 32 cm/sec in + x direction

(d) 64 cm/sec in + x direction

23. The equation of a progressive wave is given by $y = a\sin(628t - 31.4x)$

If the distances are expressed in cms and time in seconds, then the wave velocity will be

(a) 314 cm/sec (b) 628 cm/sec

(c) 20 cm/sec (d) 400 cm/sec

24. The relation between time and displacement for two particles is given by

$y_1 = 0.06\sin 2\pi(0.04t + \phi_1)$, $y_2 = 0.03\sin 2\pi(1.04t + \phi_2)$

The ratio of the intensity of the waves produced by the vibrations of the two particles will be

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

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

25. A plane wave is represented by

$x = 1.2 \sin(314\ t + 12.56 y)$

Where x and y are distances measured along in x and y direction in meters and t is time in seconds. This wave has

(a) A wavelength of 0.25 m and travels in + ve x direction

(b) A wavelength of 0.25 m and travels in + ve y direction

(c) A wavelength of 0.5 m and travels in – ve y direction

(d) A wavelength of 0.5 m and travels in – ve x direction

26. The displacement y (in cm) produced by a simple harmonic wave is $y = \frac{10}{\pi} \sin\left(2000\pi t - \frac{\pi x}{17}\right)$. The periodic time and maximum velocity of the particles in the medium will respectively be

(a) 10^{-3} sec and 330 m/sec (b) 10^{-4} sec and 20 m/sec

(c) 10^{-3} sec and 200 m/sec (d) 10^{-2} sec and 2000 m/sec

27. A transverse wave of amplitude 0.5 m and wavelength 1 m and frequency 2 Hz is propagating in a string in the negative x-direction. The expression for this wave is

(a) $y(x,t) = 0.5 \sin(2\pi x - 4\pi t)$

(b) $y(x,t) = 0.5 \cos(2\pi x + 4\pi t)$

(c) $y(x,t) = 0.5 \sin(\pi x - 2\pi t)$

(d) $y(x,t) = 0.5 \cos(2\pi x + 2\pi t)$

28. The displacement of a particle is given by $y = 5 \times 10^{-4} \sin(100 t - 50 x)$, where x is in meter and t in sec, find out the velocity of the wave

(a) 5000 m/sec (b) 2 m/sec

(c) 0.5 m/sec (d) 300 m/sec

29. Which one of the following does not represent a travelling wave

(a) $y = \sin(x - v t)$ (b) $y = y_m \sin k(x + v t)$ (c) $y = y_m \log(x - v t)$ (d) $y = f(x^2 - v t^2)$

30. A wave represented by the given equation $Y = A \sin\left(10\pi x + 15\pi t + \frac{\pi}{3}\right)$, where x is in meter and t is in second. The expression represents

(a) A wave travelling in the positive X direction with a velocity of 1.5 m/sec

(b) A wave travelling in the negative X direction with a velocity of 1.5 m/sec

(c) A wave travelling in the negative X direction with a wavelength of 0.4 m

(d) A wave travelling in the positive X direction with a wavelength of 0.2 m

31. A plane wave is described by the equation $y = 3\cos\left(\frac{x}{4} - 10t - \frac{\pi}{2}\right)$. The maximum velocity of the particles of the medium due to this wave is

(a) 30 (b) $\frac{3\pi}{2}$

(c) 3/4 (d) 40

32. The path difference between the two waves $y_1 = a_1 \sin\left(\omega t - \frac{2\pi x}{\lambda}\right)$ and $y_2 = a_2 \cos\left(\omega t - \frac{2\pi x}{\lambda} + \phi\right)$ is

(a) $\frac{\lambda}{2\pi}\phi$ (b) $\frac{\lambda}{2\pi}\left(\phi + \frac{\pi}{2}\right)$ (c) $\frac{2\pi}{\lambda}\left(\phi - \frac{\pi}{2}\right)$ (d) $\frac{2\pi}{\lambda}\phi$

33. Wave equations of two particles are given by $y_1 = a\sin(\omega t - kx)$, $y_2 = a\sin(kx + \omega t)$, then

(a) They are moving in opposite direction

(b) Phase between them is 90°

(c) Phase between them is 180°

(d) Phase between them is 0°

34. The equation of progressive wave is $y = 0.2\sin 2\pi\left[\frac{t}{0.01} - \frac{x}{0.3}\right]$, where x and y are in meter and t is in second. The velocity of propagation of the wave is

(a) 30 m/s (b) 40 m/s

(c) 300 m/s (d) 400 m/s

35. When two sound waves with a phase difference of $\pi/2$, and each having amplitude A and frequency ω, are superimposed on each other, then the maximum amplitude and frequency of resultant wave is

(a) $\frac{A}{\sqrt{2}} : \frac{\omega}{2}$ (b) $\frac{A}{\sqrt{2}} : \omega$

(c) $\sqrt{2}A : \frac{\omega}{2}$ (d) $\sqrt{2}A : \omega$

36. If the phase difference between the two wave is 2π during superposition, then the resultant amplitude is

(a) Maximum (b) Minimum

(c) Maximum or minimum (d) None of the above

37. The intensity ratio of two waves is 1: 16. The ratio of their amplitudes is

(a) 1 : 16 (b) 1 : 4

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

38. Out of the given four waves (1), (2), (3) and (4)

$y = a\sin(kx + \omega t)$ ...... (1)

$y = a\sin(\omega t - kx)$ ...... (2)

$y = a\cos(kx + \omega t)$ ...... (3)

$y = a\cos(\omega t - kx)$ ...... (4)

emitted by four different sources S_1, S_2, S_3 and S_4 respectively, interference phenomena would be observed in space under appropriate conditions when

(a) Source S_1 emits wave (1) and S_2 emits wave (2)

(b) Source S_3 emits wave (3) and S_4 emits wave (4)

(c) Source S_2 emits wave (2) and S_4 emits wave (4)

(d) S_4 emits waves (4) and S_3 emits waves (3)

39. The superposing waves are represented by the following equations :

$y_1 = 5\sin 2\pi(10\,t - 0.1x)$, $y_2 = 10\sin 2\pi(20\,t - 0.2x)$

Ratio of intensities $\frac{I_{max}}{I_{min}}$ will be

(a) 1 (b) 9

(c) 4 (d) 16

40. The displacement of a particle is given by

$x = 3\sin(5\pi\,t) + 4\cos(5\pi\,t)$

The amplitude of the particle is

(a) 3 (b) 4

(c) 5 (d) 7

41. Two waves

$y_1 = A_1\sin(\omega t - \beta_1)$, $y_2 = A_2\sin(\omega t - \beta_2)$

Superimpose to form a resultant wave whose amplitude is

(a) $\sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos(\beta_1 - \beta_2)}$

(b) $\sqrt{A_1^2 + A_2^2 + 2A_1A_2\sin(\beta_1 - \beta_2)}$

(c) $A_1 + A_2$

(d) $|\ A_1 + A_2\ |$

42. If the ratio of amplitude of wave is 2 : 1, then the ratio of maximum and minimum intensity is

(a) 9 : 1 (b) 1 : 9

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

43. In stationary wave

(a) Strain is maximum at nodes

(b) Strain is maximum at antinodes

(c) Strain is minimum at nodes

(d) Amplitude is zero at all the points

44. Which of the property makes difference between progressive and stationary waves

(a) Amplitude (b) Frequency

(c) Propagation of energy (d)Phase of the wave

45. Stationary waves are formed when

(a) Two waves of equal amplitude and equal frequency travel along the same path in opposite directions

(b) Two waves of equal wavelength and equal amplitude travel along the same path with equal speeds in opposite directions

(c) Two waves of equal wavelength and equal phase travel along the same path with equal speed

(d) Two waves of equal amplitude and equal speed travel along the same path in opposite direction

46. For the stationary wave $y = 4\sin\left(\frac{\pi x}{15}\right)\cos(96\,\pi t)$, the distance between a node and the next antinode is

(a) 7.5 (b)15

(c) 22.5 (d) 30

47. The equation $\vec{\phi}(x,t) = \vec{j}\,\sin\left(\frac{2\pi}{\lambda}v\,t\right)\cos\left(\frac{2\pi}{\lambda}x\right)$ represents

(a) Transverse progressive wave

(b) Longitudinal progressive wave

(c) Longitudinal stationary wave

(d) Transverse stationary wave

48. The equation of a stationary wave is $y = 0.8\cos\left(\frac{\pi x}{20}\right)\sin 200\,\pi t$, where x is in cm and t is in sec. The separation between consecutive nodes will be

(a) 20 cm (b) 10 cm

(c) 40 cm (d) 30 cm

49. In a stationary wave, all particles are

(a) At rest at the same time twice in every period of oscillation

(b) At rest at the same time only once in every period of oscillation

(c) Never at rest at the same time

(d) Never at rest at all

50. 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

51. 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

52. A wave travelling along positive x-axis is given by $y = A\sin(\omega t - kx)$. If it is reflected from rigid boundary such that 80% amplitude is reflected, then equation of reflected wave is

(a) $y = A\sin(\omega t + kx)$ (b) $y = -0.8A\sin(\omega t + kx)$

(c) $y = 0.8A\sin(\omega t + kx)$ (d) $y = A\sin(\omega t + 0.8\,kx)$

53. 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 centimeter and t in second. The separation between two adjacent nodes is :

(a) 6 cm (b) 4 cm

(c) 3 cm (d) 1.5 cm

54. A sonometer wire is vibrating in the second overtone. In the wire there are

1) two nodes and two antinodes

2) one node and two antinodes

3) four nodes and three antinodes 4) three nodes and three antinodes

55. The types of waves produced in a sonometer wire are

1) transverse progressive

2) transverse stationary

3) longitudinal progressive

4) longitudinal stationary

KEY

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

HINTS

2. $v = n\lambda = 2\times 5 = 10$ cm/sec

3. $v = n\lambda \Rightarrow \lambda = \frac{v}{n} = \frac{330}{256} = 1.29m$ \

4. $t = \frac{d}{v} = \frac{2000}{330} = 6.06$ Sec ≈ 6 sec

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

7. $1.6\pi = \frac{2\pi}{\lambda}\times 40 \Rightarrow \lambda = 50\ cm = 0.5$m

$v = n\lambda \Rightarrow 330 = 0.5\times n \Rightarrow n = 660\ Hz$

8. $\lambda = \frac{v}{n}; n \approx 50{,}000\ Hz$, $v = 330$ m/sec $\Rightarrow$

$\lambda = \frac{330}{50000} = 6.6\times 10^{-5} cm \approx 5\times 10^{-5} cm$

10. $\lambda = \frac{v}{n} = \frac{1.7\times 1000}{4.2\times 10^{6}} = 4\times 10^{-4}\ m$

12. $v \propto \lambda \Rightarrow \frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2} = \frac{2/3}{3/10} = \frac{20}{9}$

19. $v = \frac{200\pi}{0.5\pi} = 400 cm/s$

20. $k = \frac{2\pi}{\lambda} = 0.02 \Rightarrow \lambda = 100\ cm$

$\Delta = \frac{\lambda}{2\pi}\times\Delta\phi = \frac{\lambda}{2\pi}\times\frac{\pi}{2} = \frac{\lambda}{4} = \frac{100}{4} = 25\ cm$

21. $2\pi = \frac{2\pi}{T}\times 0.2 \Rightarrow \frac{1}{T} = 5\sec^{-1} \Rightarrow n = 5\ Hz$

22. $v = \frac{4\pi}{\pi/16} = 64\ cm/sec$ along +x direction.

24. $\frac{I_1}{I_2} = \frac{a_1^2}{a_2^2} = \left(\frac{0.06}{0.03}\right)^2 = \frac{4}{1}$

25. $k = \frac{2\pi}{\lambda} = 12.56 \Rightarrow \lambda = \frac{2\times 3.14}{12.56} = 0.5\,m$

26. $a = \frac{10}{\pi}, \omega = 200\ \pi$

$\therefore\ v_{\max} = a\omega = \frac{10}{\pi}\times 2000\ \pi = 200\,m/\sec$

and $\omega = \frac{2\pi}{T} \Rightarrow 200\,\pi = \frac{2\pi}{T} \Longrightarrow T = 10^{-3}$ sec

27. $y = a\cos\left(\frac{2\pi}{\lambda}vt + \frac{2\pi x}{\lambda}\right) = 0.5\cos(4\pi t + 2\pi x)$

30. $\omega = 2\pi n = 15\pi,\ k = \frac{2\pi}{\lambda} = 10\pi$

v $= \frac{\omega}{k} = \frac{15\pi}{10\pi} = 1.5$ m/sec

37. $\frac{I_1}{I_2} = \left(\frac{a_1}{a_2}\right)^2 = \frac{1}{16} \Rightarrow \frac{a_1}{a_2} = \frac{1}{4}$

39. $a_1 = 5,\ a_2 = 10 \Rightarrow \frac{I_{\max}}{I_{\min}} = \frac{(a_1+a_2)^2}{(a_1-a_2)^2} = \left(\frac{5+10}{5-10}\right)^2 = \frac{9}{1}$

40. $a_1 = 3,\ a_2 = 4$ and $\phi = \frac{\pi}{2}$

$\Longrightarrow A = \sqrt{a_1^2 + a_2^2 + 2a_1a_2\cos\pi/2} = \sqrt{(3)^2 + (4)^2} = 5$

42. $\frac{I_{\max}}{I_{\min}} = \left(\frac{\frac{a_1}{a_2}+1}{\frac{a_1}{a_2}-1}\right)^2 = \left(\frac{2+1}{2-1}\right)^2 = 9/1$

46. $\frac{2\pi}{\lambda} = \frac{\pi}{15} \Rightarrow \lambda = 30$

Required distance = $\frac{\lambda}{4} = \frac{30}{4} = 7.5$

48. $\frac{2\pi}{\lambda} = \frac{\pi}{20} \Rightarrow \lambda = 40$

Required distance = $\frac{\lambda}{2} = \frac{40}{2} = 20\ cm$

53. $y = 5\sin\frac{\pi x}{3}\cos 40\,\pi t$

$y = 2a\cos\frac{2\pi vt}{\lambda}\sin\frac{2\pi x}{\lambda} \Rightarrow \lambda = 6\,cm.$

Required distance $= \frac{\lambda}{2} = 3\,cm.$

BEATS

1. **Two tuning forks when sounded together produced 4 beats/sec. The frequency of one fork is 256. The number of beats heard increases when the fork of frequency 256 is loaded with wax. The frequency of the other fork is**

   (a) 504 (b) 520

   (c) 260 (d)252

2. **A tuning fork of frequency 100 when sounded together with another tuning fork of unknown frequency produces 2 beats per second. On loading the tuning fork whose frequency is not known and sounded together with a tuning fork of frequency 100 produces one beat, then the frequency of the other tuning fork is**

   (a) 102 (b) 98

   (c) 99 (d) 101

3. **A tuning fork sounded together with a tuning fork of frequency 256 emits two beats. On loading the tuning fork of frequency 256, the numbers of beats heard are 1 per second. The frequency of tuning fork is**

   (a) 257 (b)258

   (c) 256 (d) 254

4. **If two tuning forks A and B are sounded together, they produce 4 beats per second. A is then slightly loaded with wax, they produce 2 beats when sounded again. The frequency of A is 256. The frequency of B will be**

   (a) 250 (b) 252

   (c) 260 (d) 262

5. **Two tuning forks have frequencies 450 Hz and 454 Hz respectively. On sounding these forks together, the time interval between successive maximum intensities will be**

   (a) 1/4 sec (b) 1/2 sec

   (c) 1 sec (d) 2 sec

6. **When a tuning fork of frequency 341 is sounded with another tuning fork, six beats per second are heard. When the second tuning fork is loaded with wax and sounded with the first tuning fork, the number of beats is two per second. The natural frequency of the second tuning fork is**

   (a) 334 (b) 339 (c)343 (d)347

7. **Two tuning forks of frequencies 256 and 258 vibrations/sec are sounded together, then time interval between consecutive maxima heard by the observer is**

(a) 2 sec (b) 0.5 sec

(c) 250 sec (d) 252 sec

8. **A tuning fork gives 5 beats with another tuning fork of frequency 100 Hz. When the first tuning fork is loaded with wax, then the number of beats remains unchanged, then what will be the frequency of the first tuning fork**

(a) 95 Hz (b) 100 Hz

(c) 105 Hz (d) 110 Hz

9. **Tuning fork F_1 has a frequency of 256 Hz and it is observed to produce 6 beats/second with another tuning fork F_2. When F_2 is loaded with wax, it still produces 6 beats/second with F_1. The frequency of F_2 before loading was**

(a) 253 Hz (b) 262 Hz

(c) 250 Hz (d) 259 Hz

10. **A tuning fork and a sonometer wire were sounded together and produce 4 beats per second. When the length of sonometer wire is 95 cm or 100 cm, the frequency of the tuning fork is**

(a) 156 Hz (b) 152 Hz

(c) 148 Hz (d) 160 Hz

11. **Two tuning forks A and B vibrating simultaneously produce 5 beats. Frequency of B is 512. It is seen that if one arm of A is filed, then the number of beats increases. Frequency of A will be**

(a) 502 (b) 507

(c) 517 (d) 522

12. **The beats are produced by two sound sources of same amplitude and of nearly equal frequencies. The maximum intensity of beats will be ...... that of one source**

(a) Same (b) Double

(c) Four times (d) Eight times

13. **Beats are produced by two waves given by $y_1 = a \sin 2000\,\pi t$ and $y_2 = a \sin 2008\,\pi t$. The number of beats heard per second is**

(a) Zero (b) One

(c) Four (d) Eight

14. **A tuning fork whose frequency as given by manufacturer is 512 Hz is being tested with an accurate oscillator. It is found that the fork produces a beat of 2 Hz when oscillator reads 514 Hz but produces a beat of 6 Hz when oscillator reads 510 Hz. The actual frequency of fork is**

(a) 508 Hz (b) 512 Hz

(c) 516 Hz (d) 518 Hz

15. **When a tuning fork A of unknown frequency is sounded with another tuning fork B of frequency 256 Hz, then 3 beats per second are observed. After that A is loaded with wax and sounded, the again 3 beats per second are observed. The frequency of the tuning fork A is**

(a) 250 Hz (b) 253 Hz

(c) 259 Hz (d) 262 Hz

16. **A source of sound gives five beats per second when sounded with another source of frequency** $100\ s^{-1}$. **The second harmonic of the source together with a source of frequency** $205\ s^{-1}$ **gives five beats per second. What is the frequency of the source**

(a) $105\ s^{-1}$ (b) $205\ s^{-1}$

(c) $95\ s^{-1}$ (d) $100\ s^{-1}$

17. **41 forks are so arranged that each produces 5 beats per sec when sounded with its near fork. If the frequency of last fork is double the frequency of first fork, then the frequencies of the first and last fork are respectively**

(a) 200, 400 (b) 205, 410

(c) 195, 390 (d) 100, 200

18. **The presence of dangerous gases in mines can be detected using the phenomenon of**

1) echo 2) Doppler effect 3) beats 4) resonance

KEY

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

HINTS

5. Time interval = $\frac{1}{n_1 \sim n_2} = \frac{1}{454 - 450} = \frac{1}{4}\,\text{sec}$.

7. $T = \frac{1}{258 - 256} =$ 0.5 sec

10. $n \propto \frac{1}{l}$

$\therefore \frac{n+4}{n-4} = \frac{100}{95}$ or $95\,(n+4) = 100\,(n-4)$

or $95n + 380 = 100n - 400$ or $5n = 780$ or $n = 156$

13. Number of beats per second = $n_1 \sim n_2$

$\omega_1 = 2000\,\pi = 2\pi n_1 \Rightarrow n_1 = 1000$

and $\omega_2 = 2008\,\pi = 2\pi n_2 \Rightarrow n_2 = 1004$

Number of beats heard per sec $= 1004 - 1000 = 4$

17. $n_{First} = n_{First} + (N - 1)x$

$2n = n \quad + (41 - 1) \times 5$

$\Rightarrow n_{First} = 200$ Hz and $n_{Last} = 400$ Hz

VIBRATION OF STRING

1. **A string fixed at both the ends is vibrating in two segments. The wavelength of the corresponding wave is**

(a) $\frac{l}{4}$ (b) $\frac{l}{2}$

(c) l (d) 2l

2. **A 1 cm long string vibrates with fundamental frequency of 256 Hz. If the length is reduced to $\frac{1}{4}cm$ keeping the tension unaltered, the new fundamental frequency will be**

(a) 64 (b) 256

(c) 512 (d) 1024

3. **Standing waves are produced in a 10 m long stretched string. If the string vibrates in 5 segments and the wave velocity is 20 m/s, the frequency is**

(a) 2 Hz (b) 4 Hz

(c) 5 Hz (d) 10 Hz

4. **The velocity of waves in a string fixed at both ends is 2 m/s. The string forms standing waves with nodes 5.0 cm apart. The frequency of vibration of the string in Hz is**

(a) 40 (b) 30

(c) 20 (d) 10

5. **Four wires of identical length, diameters and of the same material are stretched on a sonometre wire. If the ratio of their tensions is 1 : 4 : 9 : 16 then the ratio of their fundamental frequencies are**

(a) 16 : 9 : 4 : 1 (b) 4 : 3 : 2 : 1

(c) 1 : 4 : 2 : 16 (d) 1 : 2 : 3 : 4

6. **The fundamental frequency of a string stretched with a weight of 4 kg is 256 Hz. The weight required to produce its octave is**

a) 4 kg wt (b) 8 kg wt

(c) 12 kg wt (d) 16 kg wt

7. **Two vibrating strings of the same material but lengths L and 2L have radii 2r and r respectively. They are stretched under the same tension. Both the strings vibrate in their fundamental modes, the one of length L with frequency n_1 and the other with frequency n_2. The ratio n_1/n_2 is given by**

(a) 2 (b) 4

(c) 8 (d) 1

8. **Three similar wires of frequency n_1, n_2 and n_3 are joined to make one wire. Its frequency will be**

(a) $n = n_1 + n_2 + n_3$ (b) $\frac{1}{n} = \frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_3}$

(c) $\frac{1}{\sqrt{n}} = \frac{1}{\sqrt{n_1}} + \frac{1}{\sqrt{n_2}} + \frac{1}{\sqrt{n_3}}$ (d) $\frac{1}{n^1} = \frac{1}{n_1^2} + \frac{1}{n_2^2} + \frac{1}{n_3^2}$

9. **A steel rod 100 cm long is clamped at its mid-point. The fundamental frequency of longitudinal vibrations of the rod is given to be 2.53 kHz. What is the speed of sound in steel**

(a) 5.06 km/s (b) 6.06 km/s

(c) 7.06 km/s (d) 8.06 km/s

10. **Two wires are producing fundamental notes of the same frequency. Change in which of the following factors of one wire will not produce beats between them**

(a) Amplitude of the vibrations (b)Material of the wire

(c) Stretching force (d)Diameter of the wires

11. **Two identical wires have the same fundamental frequency of 400 Hz. when kept under the same tension. If the tension in one wire is increased by 2% the number of beats produced will be**

(a) 4 (b) 2

(c) 8 (d) 1

12. **Two identical straight wires are stretched so as to produce 6 beats per second when vibrating simultaneously. On changing the tension in one of them, the beat frequency remains unchanged. Denoting by T_1, T_2, the higher and the lower initial tensions in the strings, then it could be said that while making the above change in tension**

(a) T_2 was decreased (b) T_2 was increased

(c) T_1 was increased (d) T_1 was kept constant

13. **The frequency of a stretched uniform wire under tension is in resonance with the fundamental frequency of a closed tube. If the tension in the wire is increased by 8 N, it is in resonance with the first overtone of the closed tube. The initial tension in the wire is**

(a) 1 N (b) 4 N

(c) 8 N (d) 16 N

14. **A metal wire of linear mass density of 9.8 g/m is stretched with a tension of 10 kg weight between two rigid supports 1 meter apart. The wire passes at its middle point between the poles of a permanent magnet, and it vibrates in resonance when carrying an alternating current of frequency n. The frequency n of the alternating source is**

(a) 25 Hz (b) 50 Hz

(c) 100 Hz (d) 200 Hz

15. **A wire of density 9×10^3 kg /m^3 is stretched between two clamps 1 m apart and is subjected to an extension of 4.9×10^{-4} m. The lowest frequency of transverse vibration in the wire is ($Y = 9 \times 10^{10}$ N / m^2)**

(a) 40 Hz (b) 35 Hz

(c) 30 Hz d) 25 Hz

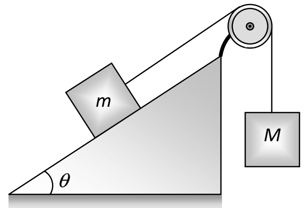
16. **A wire of $9.8 \times 10^{-3} kgm^{-1}$ passes over a frictionless light pulley fixed on the top of a frictionless inclined plane which makes an angle of 30° with the horizontal. Masses m and M are tied at the two ends of wire such that m rests on the plane and M hangs freely vertically downwards. The entire system is in equilibrium and a transverse wave propagates along the wire with a velocity of 100 ms^{-1}. Chose the correct option**

(a) $m = 20\,kg$

(b) $m = 5\,kg$

(c) $m = 2\,kg$

(d) $m = 7\,kg$



17. **A stone is hung in air from a wire which is stretched over a sonometer. The bridges of the sonometer are L cm apart when the wire is in unison with a tuning fork of frequency N. When the stone is completely immersed in water, the length between the bridges is l cm for re-establishing unison, the specific gravity of the material of the stone is**

(a) $\frac{L^2}{L^2 + l^2}$ (b) $\frac{L^2 - l^2}{L^2}$

(c) $\frac{L^2}{L^2 - l^2}$ (d) $\frac{L^2 - l^2}{L^2}$

KEY

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

HINTS

2. $n \propto \frac{1}{l} \Rightarrow \frac{n_2}{n_1} = \frac{l_1}{l_2} \Rightarrow n_2 = \frac{l_1}{l_2} n_1 = \frac{1 \times 256}{1/4} = 1024\,Hz$

3. $\frac{5}{2}\lambda = l \Rightarrow \lambda = \frac{2l}{5}$

$n = \frac{5v}{2l} = \frac{5 \times 20}{2 \times 10} = 5\ Hz$

4. $\frac{\lambda}{2} = 5.0\,cm \quad \Rightarrow \lambda = 10\ cm$

$n = \frac{v}{\lambda} = \frac{200}{10} = 20$ Hz.

5. $v=\frac{\omega}{k}=\frac{30}{1}=30\ m/s$.

, $v=\sqrt{\frac{T}{m}} \Rightarrow 30=\sqrt{\frac{T}{1.3\times10^{-4}}} \Rightarrow T=0.117$ N

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

$n'=2n$

$\Rightarrow \frac{n'}{n}=\sqrt{\frac{T'}{T}}=2 \Rightarrow T'=4T=16kg\text{-}wt$

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

$n\propto=\frac{1}{lr} \Rightarrow \frac{n_1}{n_2}=\frac{r_2}{r_1}\times\frac{l_2}{l_1}=\frac{r}{2r}\times\frac{2L}{L}=\frac{1}{1}$

8. $n=\frac{1}{2l}\sqrt{\frac{T}{m}} \Rightarrow n_1l_1=n_2l_2=n_3l_3=k$

$l_1+l_2+l_3=l \Rightarrow \frac{k}{n_1}+\frac{k}{n_2}+\frac{k}{n_3}=\frac{k}{n}$

$\Rightarrow \frac{1}{n}=\frac{1}{n_1}+\frac{1}{n_2}+\frac{1}{n_3}+........$

11. $n\propto\sqrt{T} \Rightarrow \frac{\Delta n}{n}=\frac{1}{2}\frac{\Delta T}{T}$

$\Delta n=\left(\frac{1}{2}\frac{\Delta T}{T}\right)n=\frac{1}{2}\times\frac{2}{100}\times400=4$

13. $\sqrt{\frac{T}{T+8}}=\frac{1}{3} \Rightarrow T=1N$

14. $n=\frac{1}{2l}\sqrt{\frac{T}{m}}=\frac{1}{2\times1}\sqrt{\frac{10\times9.8}{9.8\times10^{-3}}}=\frac{100}{2}=50\ Hz$

15. $n=\frac{1}{2l}\sqrt{\frac{T}{m}}=\frac{1}{2l}\sqrt{\frac{y\Delta l}{l\rho}}$

$\Rightarrow n=\frac{1}{2\times1}\sqrt{\frac{9\times10^{10}\times4.9\times10^{-4}}{1\times9\times10^{3}}}=35Hz$

ORGAN PIPE (VIBRATION OF AIR COLUMN)

1. The length of two open organ pipes are l and $(l+\Delta l)$ respectively. Neglecting end correction, the frequency of beats between them will be approximately

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

(c) $\frac{v\Delta l}{2l^2}$ (d) $\frac{v\Delta l}{l}$

(Here v is the speed of sound)

2. A tube closed at one end and containing air is excited. It produces the fundamental note of frequency 512 Hz. If the same tube is open at both the ends the fundamental frequency that can be produced is

(a) 1024 Hz (b) 512 Hz

(c) 256 Hz (d) 128 Hz

3. A closed pipe and an open pipe have their first overtones identical in frequency. Their lengths are in the ratio

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

(c) 3 : 4 (d) 4 : 5

4. The first overtone in a closed pipe has a frequency

(a) Same as the fundamental frequency of an open tube of same length

(b) Twice the fundamental frequency of an open tube of same length

(c) Same as that of the first overtone of an open tube of same length

(d) None of the above

5. An empty vessel is partially filled with water, then the frequency of vibration of air column in the vessel

(a) Remains same

(b) Decreases

(c) Increases

(d) First increases then decreases

6. It is desired to increase the fundamental resonance frequency in a tube which is closed at one end. This cannot be achieved by

(a) Replacing the air in the tube by hydrogen gas (b) Increasing the length of the tube

(c) Decreasing the length of the tube (d)Opening the closed end of the tube

7. **The stationary wave** $y = 2a \sin kx \cos \omega t$ **in a closed organ pipe is the result of the superposition of** $y = a\sin(\omega t - kx)$ **and**

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

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

8. **Stationary waves are set up in air column. Velocity of sound in air is 330 m/s and frequency is 165 Hz. Then distance between the nodes is**

(a) 2 m (b) 1 m

(c) 0.5 m (d) 4 m

9. **An open pipe of length l vibrates in fundamental mode. The pressure variation is maximum at**

(a) 1/4 from ends

(b) The middle of pipe

(c) The ends of pipe

(d) At 1/8 from ends of pipe middle of the pipe.

10. **A pipe open at both ends produces a note of frequency f_1. When the pipe is kept with** $\frac{3}{4}$ **th of its length it water, it produced a note of frequency f_2. The ratio** $\frac{f_1}{f_2}$ **is**

(a) $\frac{3}{4}$ (b) $\frac{4}{3}$

(c) $\frac{1}{2}$ (d) 2

KEY

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

HINTS

1. $\lambda_1 = 2l, \lambda_2 = 2l + 2\Delta l \Rightarrow n_1 = \frac{v}{2l}$ and $n_2 = \frac{v}{2l + 2\Delta l}$

   No. of beats $= n_1 - n_2 = \frac{v}{2}\left(\frac{1}{l} - \frac{1}{l+\Delta l}\right) = \frac{v\Delta l}{2l^2}$

3. $3\left(\frac{v}{4l_1}\right) = 2\left(\frac{v}{2l_2}\right)$; where l_1 and l_2 are the lengths of closed and open organ pipes hence $\frac{l_1}{l_2} = \frac{3}{4}$

8. $v = 330\ m/s$; $n = 165\ Hz$.

   Required distance $= \frac{\lambda}{2} = \frac{v}{2n} = \frac{330}{2\times 165} = 1m$

10. For open pipe $f_1 = \frac{v}{2l}$

    For closed pipe

    $f_2 = \frac{v}{4\times\left(\frac{l}{4}\right)} = \frac{v}{l} = 2f_1 \Rightarrow \frac{f_1}{f_2} = \frac{1}{2}$

DOPPLER'S EFFECT

1. Doppler shift in frequency does not depend upon

(a) The frequency of the wave produced

(b) The velocity of the source

(c) The velocity of the observer

(d) Distance from the source to the listener

2. A source of sound of frequency 450 cycles/sec is moving towards a stationary observer with 34 m/sec speed. If the speed of sound is 340 m/sec, then the apparent frequency will be

(a) 410 cycles/sec (b) 500 cycles/sec

(c) 550 cycles/sec (d) 450 cycles/sec

3. A source of sound emits waves with frequency f Hz and speed V m/sec. Two observers move away from this source in opposite directions each with a speed 0.2 V relative to the source. The ratio of frequencies heard by the two observers will be

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

(c) 1 : 1 (d) 4 : 10

4. **The source producing sound and an observer both are moving along the direction of propagation of sound waves. If the respective velocities of sound, source and an observer are v, v_s and v_o, then the apparent frequency heard by the observer will be (n = frequency of sound)**

(a) $\frac{n(v+v_o)}{v-v_o}$ (b) $\frac{n(v-v_o)}{v-v_s}$

(c) $\frac{n(v-v_o)}{v+v_s}$ (d) $\frac{n(v+v_o)}{v+v_s}$

5. **An observer moves towards a stationary source of sound of frequency n. The apparent frequency heard by him is 2n. If the velocity of sound in air is 332 m/sec, then the velocity of the observer is**

(a) 166 m/sec (b) 664 m/sec

(c) 332 m/sec (d) 1328 m/sec

6. **A person feels 2.5% difference of frequency of a motor-car horn. If the motor-car is moving to the person and the velocity of sound is 320 m/sec, then the velocity of car will be**

(a) 8 m/s (approx.) (b) 800 m/s

(c) 7 m/s (d) 6 m/s (approx.)

7. **Two passenger trains moving with a speed of 108 km/hour cross each other. One of them blows a whistle whose frequency is 750 Hz. If sound speed is 330 m/s, then passengers sitting in the other train, after trains cross each other will hear sound whose frequency will be**

(a) 900 Hz (b) 625 Hz

(c) 750 Hz (d) 800 Hz

8. **With what velocity an observer should move relative to a stationary source so that he hears a sound of double the frequency of source**

(a) Velocity of sound towards the source

(b) Velocity of sound away from the source

(c) Half the velocity of sound towards the source

(d) Double the velocity of sound towards the source

9. **A source of sound emitting a note of frequency 200 Hz moves towards an observer with a velocity v equal to the velocity of sound. If the observer also moves away from the source with the same velocity v, the apparent frequency heard by the observer is**

(a) 50 Hz (b) 100 Hz (c) 150 Hz (d) 200 Hz

10. A source of sound is travelling towards a stationary observer. The frequency of sound heard by the observer is of three times the original frequency. The velocity of sound is v m/sec. The speed of source will be

(a) $\frac{2}{3}v$ (b) v

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

11. A source of frequency 150 Hz is moving in the direction of a person with a velocity of 110 m/s. The frequency heard by the person will be (speed of sound in medium = 330 m/s)

(a) 225 Hz (b) 200 Hz

(c) 150 Hz (d) 100 Hz

12. The Doppler's effect is applicable for

(a) Light waves (b) Sound waves

(c) Space waves (d) Both (a) and (b)

13. A source of sound is moving with constant velocity of 20 m/s emitting a note of frequency 1000 Hz. The ratio of frequencies observed by a stationary observer while the source is approaching him and after it crosses him will be

(a) 9 : 8 (b) 8 : 9

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

(Speed of sound v = 340 m/s)

14. A source of sound S is moving with a velocity 50m/s towards a stationary observer. The observer measures the frequency of the source as 1000 Hz. What will be the apparent frequency of the source when it is moving away from the observer after crossing him? The velocity of sound in the medium is 350 m/s

(a) 750 Hz (b) 857 Hz

(c) 1143 Hz (d) 1333 Hz

15. A motor car blowing a horn of frequency 124vib/sec moves with a velocity 72 km/hr towards a tall wall. The frequency of the reflected sound heard by the driver will be (velocity of sound in air is 330 m/s)

(a) 109 vib/sec (b) 132 vib/sec

(c) 140 vib/sec (d) 248 vib/sec

16. **A source of sound of frequency n is moving towards a stationary observer with a speed S. If the speed of sound in air is V and the frequency heard by the observer is n_1, the value of n_1 / n is**

(a) $(V+S)/V$ (b) $V/(V+S)$

(c) $(V-S)/V$ (d) $V/(V-S)$

17. **A vehicle with a horn of frequency n is moving with a velocity of 30 m/s in a direction perpendicular to the straight line joining the observer and the vehicle. The observer perceives the sound to have a frequency $n+n_1$. Then (if the sound velocity in air is 300 m/s)**

(a) $n_1 = 10\,n$ (b) $n_1 = 0$

(c) $n_1 = 0.1\,n$ (d) $n_1 = -0.1\,n$

18. **The driver of a car travelling with speed 30 meters per second towards a hill sounds a horn of frequency 600 Hz. If the velocity of sound in air is 330 meters per second, the frequency of the reflected sound as heard by the driver is**

(a) 720 Hz (b) 555.5 Hz

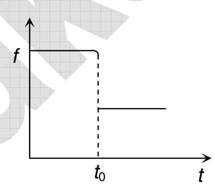
(c) 550 Hz (d) 500 Hz

19. **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

20. **A man is standing on a railway platform listening to the whistle of an engine that passes the man at constant speed without stopping. If the engine passes the man at time t_0. How does the frequency f of the whistle as heard by the man changes with time**

(a)


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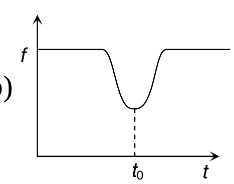

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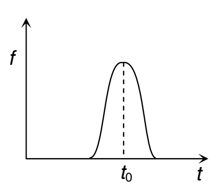

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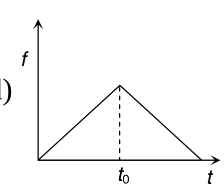

KEY

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

HINTS

2. $n' = n\left(\frac{v}{v - v_O}\right) = 450\left(\frac{340}{340 - 34}\right) = 500\ \ cycles\ /\ \sec$

5. $2n = n\left(\frac{v + v_0}{v}\right) \Rightarrow \frac{v + v_0}{v} = 2$

$v_O = v = 332$ m/sec

6. $102.5 = \frac{100 \times 320}{(320 - v_S)} \Rightarrow v_s = 8\ \ m\ /\ \sec$

7. $n' = n\left(\frac{v - v_O}{v + v_S}\right) = 750\left(\frac{330 - 180 \times \frac{5}{18}}{330 + 108 \times \frac{5}{18}}\right) = 625\ \ Hz$

10. $n' = n\left(\frac{v}{v - v_S}\right) \Rightarrow \frac{n'}{n} = \frac{v}{v - v_S} \Rightarrow \frac{v}{v - v_S} = 3 \Rightarrow v_s = \frac{2v}{3}$

11. $n' = \left(\frac{v}{v - v_s}\right)n = \left(\frac{330}{330 - 110}\right)150 = 225\,Hz$

13. $\frac{n_a}{n_r} = \frac{v + v_S}{v - v_S} = \frac{340 + 20}{340 - 20} = \frac{9}{8}.$

14. $\frac{1000}{n_r} = \frac{350 + 50}{350 - 50} \Rightarrow n_r = 750\,Hz.$

15. $n' = n\left(\frac{v + v_0}{v - v_s}\right) = 124\left[\frac{330 + 20}{330 - 20}\right]$ = 140 vibration/sec.

18. $n' = n\left(\frac{v + v_0}{v - v_s}\right) = 600\left[\frac{330 + 30}{330 - 30}\right] = 720\ \ Hz.$