PHYSICS

BOOKS - CENGAGE PHYSICS (HINGLISH)

WAVES

Question Bank

1. A string of length $1m$ fixed at both ends is vibrating in 3^{rd} overtone. Tension in string is $200N$ and linear mass density is 5 gmin. Frequency of these vibrations is (in Hz).

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2. You have a microwave generator that can produce microwaves at any frequency between 1 GHz and I0 GHz . The microwave radiation enters a $10cm$ long cylinder with reflective and caps, as shown in the figure. What frequency of the microwave generator (in GHz) will produce the lowest-order' standing wave with an antinode (maximum) in the center of the cavity? Note that with reflectors at both ends, the electromagnetic standing wave acts just like the standing wave on a string that is tied at both ends. Take velocity of waves as 3×10^8 m / s.

'(##CEN_KSR_PHY_JEE_C17_E01_002_Q01##)'

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3. A point source of power 50π watts is producing sound waves. The velocity of sound is 330 m / s, density of air is $1.0 kgm^{-3}$. Then at $r = \sqrt{330}$ m from the point source pressure amplitude is (in Nm^{-2}). (Using $\pi = \frac{22}{7}$)

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4. A wave is given by the equation $y = 10 \sin 2\pi(100t - .02x) + 10 \sin 2\pi(100t + .02x)$ The loop length of the stationary wave produced will be

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5. To determine the sound propagation velocity in air by ncoustic resonance techique one can use a pipe with a piston and a sonic membrane closing one of its ends. If the distance between the adjacent positions of the piston at which resonance is observed at a frequency $f = 1600 Hz$ is $\lambda = 10 cm$, the velocity of sound will be (in m / s).

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6. Two sources of sound A and B, each having natural frequency $68 Hz$ lying on opposite sides of observer O. Both move with velocity 20 m / s relative to stationary 0 . A mioves away from the observer while the B moves towards him. A wind with a speed 20 m / s is blowing in the direction of motion of A. The beat frequency measured by,

the observer (in Hz) will be (speed of sound in air 340 m / s).

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7. A wave with a frequency of $30 Hz$ travels' along a string at a speed of 36 meters per second and reflects off from a free end. How far (in m) is the first node from the end of the string.

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8. The vibrations of a string of length $60cm$ fixed at both cnds are represented by the equation.

$y = 4\sin\left(\frac{\pi x}{/}(15)\right)\cos(96\pi t)$, where x and y are in cm and t in second. The maximum displacement (in cm) at $x = \frac{5}{2}$ (cm) is

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9. Organ pipe P_1 closed at one end vibrating in its first harmonic and another pipe P_2 open at both cnds vibrating in its third harmonic are in resonsnce with a given tuning. fork. The ratio of the length of P_2 to that of P_1 is

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10. If the velocity of sound in hydrogen at $27^\circ C$ is 1200 ms^{-1}, velocity of sound in oxygen (in ms^{-1}) at the same temperature will be

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11. When a transverse plene wave tfanverses a medium, judividual particles execute pcriodic motion given by equation $y = 4\sin\frac{\pi}{/}(2)\left(2t + \frac{x}{/}(8)\right)$. The phase difference (in degrec) for two position of same particle which are occupied by time intervals $0.4s$ apart is

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12. If the sound heard by observer, whose equation is given as $y = 8\sin(10\pi t)$ cos $(200\pi t)$ at $x = 0$, then number of beat frequency heard by observer is $2k$. Then the value of k is

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13. Two electric trains run at the same speed of $v = 90k\frac{m}{h}r$ along a straight track one after the other with an interval of $l = 2.0km$ between them. At the instant when they are located symmetrically relative to point A at a distance of $b = 1.0km$ from the track (figure) both trains give a brief sound signal of the same frequency of $v = 50Hz$. What will the number of beats beard per second at point (A) when the vibrations produced by the signals arrive at it? The speed of sound is v=350 m/ s. Round off to nearest integer.

'(##CEN_KSR_PHY_JEE_C17_E01_014_Q03##)'

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14. If a string of lerigth l.fixed at both ends vibrates with a standing wave $y = A\sin\left(\frac{2\pi}{/}(l)x\right)\sin(2\pi t)$ in resonance.Then the minimum time after which energy is maximuru at mid-point of string will be (in s)

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15. A string AB of length $5m$ and linear mass denity $1kgm^{-1}$ is clamped at both the ends with

a tension of 144 N. Find minimum frequency (in H z) of transverse standing wave in string so that a node appears at a distance $3m$ from end A.

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16. Two identical strings of same length are clamped at both the eads. Both strings vibrate 'with same fundamental frequency. If tension in one of the strings is increased by 21%, then 8 beats are produced per second. If fundamental frequency of strings in initial state is $10x Hz. F \in d$x`.

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17. A police car moving at 40 m / s chases a thief running away at speed of 30 m /s. The track is perpendicular to a stiff cliff as shown. The police man blows a hom at 40 Hz. If sound has a speed of 340m / s, what is the beat frequency (in Hz) heard by the thief?

'(##CEN_KSR_PHY_JEE_C17_E01_018_Q04##)'

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18. A transverse wave is travelling on a string with velocity v. The shape of string at $t=1s$ is given by $y=\frac{5}{7}(x^2+6x+9)$ and at $f:2s$, it is given by $y=\frac{5}{7}(x^2+12x+36)$, then fill the value of $(v+c)$, where c denotes the direction of motion of wave ($+1$ for positive x -direction & -1 for $-ve$ x -direction).

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19. Fundamental frequency of a stretched sonometer wric is f_0. When its tension is increased by 96% and length decreased by 35%, its fundamental frequency becomes $\eta_1 f_0$. When its tension is decreased by 36% and its length is increased by 30%, its fundamental frequency becomes $\eta_2 f_0$. The value of $\frac{\eta_1}{/}(\eta_2)$ is found to be $\frac{7}{/}(n)$. Find n.

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20. A string of length l is fixed at both ends. It is vibrating in its 3^{rd} overtone with maximum amplitude $a = 2\sqrt{3}$ mun. Find the square of amplitude (in $(\min)^2$) at a distance $\frac{l}{7}(3)$ from one end.

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21. A uniform rope of length $12m$ and having a mass $6kg$ hangs" vertically froma rigid support. A block of mass. $2kg$ is attached to the free end of rope. A transverse pulse of wavelength $0.06m$ is prođuced at the lower end of rope. Its wavelength when it reeches the top end of the rope is given by αm. Find 50α.

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22. A progressive wave on a string having linear mass density ρ is represented by $y = A\sin\left(\frac{2\pi}{/}(\lambda)x - \omega t\right)$ wherc y is in (mm). Find the total energy (in μJ) passing through origin from $t = 0$ to $t = \frac{\pi}{/}(20)$.

[Take: $\rho = 3 \times 10^{-2}$ kg/ m , A=1 mm , $\omega = 100ra\frac{d}{s}$,$\lambda = 16cm$]

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23. A wire is made by welding together two metals having different densitics. Figure shows a $2.00m$ long section of wire centered on the junction, but the wire extends much farther in both directions. The wire is placed under 2250 N tension, thena $1500Hz$ wave with an amplitude of $3.00mm$ is sent down the wire. How many wavelengths (complete cycles) of the wave are in this $2.00m$ long section of the wire?

'(##CEN_KSR_PHY_JEE_C17_E01_024_Q05##)' figure

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24. A gas is a mixture of two parts by volume of hyprogen and part by volume of nitrogen at STP. If the velocity of sound in hydrogen at $0^{\circ}C$ is $1300m/s$. Find the velocity of sound in the gaseous mixure at $27^{\circ}C$.

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25. Two identical wires, one made of iron and the other of aluminum are stretched along-side on a sonometer board by equal stretching forces, Density of iron $= 7.5$ gm/cc, dénsity.of aluminum $= 27\frac{g}{]}$. The frequency of lowest harmonic for which both wires vibrate in unison, given that tbe length of the wires is $1m$, their diameters $1mm$ and tension 75π is givcn as $\beta(kHz)$, Find the value of 12 β.

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26. A siren placed st a railway platform is emitting sound of frequency $5kHz$. A passenger sitting in a moving train A records a frequency of $5.5kHz$ while the train approaches the siren. During bis retum joumey in a differeat train B he records a frequency of $6.0kHz$ while approaching the same siren. Find the ratio of the velocity of train B to that of $opera \rightarrow rname(tra \in)A$.

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27. The three identical loud speakcrs in figure play a $170Hz$ frequency tone in a room where speed of sound is 340 m / s. At point exactly infront of source S_2 the amplitude of the wáve from each speaker is a. What is ratio of resultant intensity at P and intensity due to single speaker. '(##CEN_KSR_PHY_JEE_C17_E01_028_Q06##)

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28. Two loudspeakers are, diriven by a common oscillator and amplifier, are arranged as shown. The frequency of the oscillator is gradually-increased from-zero and the detector at D records a series of maxima and minima. If speed of sound is 330 m / s , then what is the frequency (in Hz) at which the first time a maxima is heard.

'(##CEN_KSR_PHY_JEE_C17_E01_029_Q07##)'

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29. A sound source (S) emits frequency of $180 Hz$ when moving towards a tigid wall with speed 5 m / s and an observer (O) is moving away from wall with speed 5 m / s. Both source and observer move on (z) straight line which is perpendicular to the wall as shown in figure. Find the number of beats, per second heard by the observer. (Speed of sound 355 m / s).

'(##CEN_KSR_PHY_JEE_C17_E01_030_Q08##)'

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30. As shown in the figure, two loudspeakers are located at point A and B. Both are vibrating in phase at a frequency (v) and P_1 and P_2 are their respective power outputs. Point C lies on a line joining the two loudspeakers at a distance of d_1 from A and d_2 from B. With both speakers switched on what is the power (in $\frac{W}{m^2}$) at point C. Take velocity of sound $= 300 ms^{-1}$, frequency' $v = 100 Hz, d_t = 1m$ and $d_2 = 1.5m, P_1 = 8\pi$ watts and $P_2 = 18\pi$ watts. Also assume that loudspeakers behave like isotropic sources. (emit sound uniformly in.all directions).

'(##CEN_KSR_PHY_JEE_C17_E01_031_Q09##)'

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31. In a resonance column apparatus, first resonance is obtained whea the water filling beaker (of cylindrical shape) is just empty as shown. The water filling beaker is lowered đown and it is seen that second resionance is obtained when beaket is filled upto brim. The wavelength of sound is given by $\frac{\alpha}{/}(10m)$. Find the value of α.

'(##CEN_KSR_PHY_JEE_C17_E01_033_Q10##)'

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32. The fundamental frequency of an open pipe would be independent of small variation in temperature at a temperature $T_0 = \frac{7}{\eta}(14\alpha)$, where α is the coefficient of linear expansion of the matcrial of the tube. Fill the value of η in OMR sheet.

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33. Standing waves are set up in a string of length 240 cm clamped hiorizontatly at both ends. The separation between any two consecutive points where displacement amplitude is $3\sqrt{2}cm$ is $20cm$.

The standing waves were set by two travelling waves of equal amplitude of $3cm$. The overtone in which the string is vibrating will be

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34. Consider an elastic string stretched befween two fixed ends A and B as sbown in figure. The speed of transverse waves in the string is v and its linear mass density is μ. The string is plucked and held in a triangular form with maximum height `h<

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35. A block string system is shown in the figure. Mass of block A, B and C is 5 kg, 2 k , and $2kg$ respectively. Mass of rod is given as $1kg$ and its length is $1m$. A wave transverse is transmitted in the rod in between the block B and C once in forward and once backward direction. Time for string wave to reach one end to other end in forward direction is $\frac{2}{/}(\sqrt{z})\left(\sqrt{x}-\sqrt{y}\right)$ sec. Find $(x+y+z)$

'(##CEN_KSR_PHY_JEE_C17_E01_036_Q12##)'

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36. In the given sonometer arrangentent, a mass M can be hung from a string, that passes over a light pulley. The string connected to a vibrator having constant frequency. When the value of M is either $16kg$ or $25kg$ standing waves are observed, however, no standing waves are observed with any mass between these values. The largest mass for which standing waves could be observed is $n \times 10^2 kg$ and frequendy of vibrator is $f(Hz)$ then find the numerical value of $n \times f$ (mass per unit length for string is 10^{-3} kg

/ m and length L=2 m).

'(##CEN_KSR_PHY_JEE_C17_E01_037_Q13##) A block string system is shown in the figure. Mass of block A, B and C is 5 kg, 2 k , and $2kg$ respectively. Mass of rod is given as $1kg$ and its length is $1m$. A wave transverse is transmitted in the rod in between the block B and C once in forward and once backward direction. Time for string wave to reach one end to other end in forward direction is $\frac{2}{7}(\sqrt{z})\left(\sqrt{x}-\sqrt{y}\right)$ sec. Find $(x+y+z)$

'(##CEN_KSR_PHY_JEE_C17_E01_036_Q12##)'

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37. Sound waves of frequendy 320 Hz are sent into the top of a vertical tube containing water at a level that can be adjusted. Standing waves are produced at two successive water levels 44 can. and 74 cm from open cud. The distance of nearest displacement antinode from open cnd (in cm) is:

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38. The diagram above shows the basic idea behind a disk siren. It consists of a disk in which there are 16 equally spaced hoies, all at the same distance from its axle. When a jct of air is directed at the holes and the disc is rotated at a particular constant rate, the frequency of the note produced is 320 Hz. When a disk containing 24 holes is rotated at $\frac{4}{3}$ times the rate then frequency of note produced is $320nHz$. Find the value of n.

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