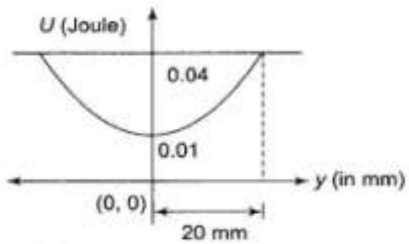
01. The variation of potential energy of harmonic oscillator is as shown in figure. The spring constant is



(a) 1×10^2 N/m (b) 150 N/m
(c) 0.667×10^2 N/m (d) 3×10^2 N/m

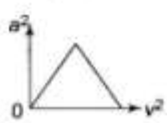
02. For a particle in S.H.M., if the amplitude of displacement is 'a' and the amplitude of velocity is 'v' the amplitude of acceleration is

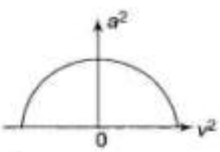
(a) va (b) $\frac{v^2}{a}$
(c) $\frac{v^2}{2a}$ (d) $\frac{v}{a}$

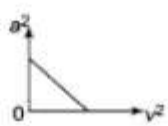
03. A particle is executing simple harmonic motion with an amplitude of 4 cm. At the mean position the velocity of the particle is 10 cm/sec. The distance of the particle from the mean position when its speed becomes 5 cm/s is:

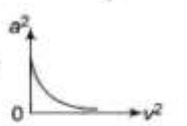
(a) $\sqrt{3}$ cm (b) $2\sqrt{2}$ cm
(c) $2\sqrt{3}$ cm (d) $3\sqrt{2}$ cm

04. A particle is in a linear SHM. If the acceleration and the corresponding velocity of this particle are 'a' and 'v', then the graph relating to these values is

(a)


(b)


(c)


(d)


05. A particle executes SHM on a straight line path. The amplitude of oscillation is 2 cm. When the displacement of the particle from the mean position is 1 cm, the numerical value of magnitude of acceleration is equal to the numerical value of magnitude of velocity. Then find out the frequency of SHM.

(a) $\sqrt{3}/2\pi$ (b) $3/2\pi$
(c) $3/\sqrt{2}\pi$ (d) $\sqrt{3}/\pi$

06. Total energy of a particle executing S.H.M. is (x is displacement from mean position):

(a) proportional to x (b) proportional to x^2
(c) independent of x (d) proportional to $x^{1/2}$

07. For a particle executing S.H.M., the kinetic energy K is given by $K = K_0 \cos^2 \omega t$. The maximum value of potential energy is:

(a) K_0 (b) zero
(c) $K_0/2$ (d) not obtainable

08. A vertical mass-spring system executes simple harmonic oscillations with a period of 2 s. A quantity of this system which exhibits simple harmonic variation with a period of 1 sec is:

(a) velocity
(b) potential energy
(c) phase difference between acceleration and displacement
(d) difference between kinetic energy and potential energy.

09. A body executes simple harmonic motion. The potential energy (PE), kinetic energy (KE) and total energy (TE) are measured as a function of displacement x. Which of the following statement is true?

(a) TE is zero when $x = 0$
(b) PE is maximum when $x = 0$
(c) KE is maximum when $x = 0$
(d) KE is maximum when x is maximum

10. A block of mass 2 kg executes simple harmonic motion under the restoring force of a spring. The amplitude and the time period of motions are 0.2 cm and 2π sec respectively. Find the maximum force exerted by the spring on the block.

(a) 0.05 N (b) 0.002 N
(c) 0.003 N (d) 0.004 N

11. The velocity v of a particle of mass m moving along a straight line changes with time 't' as $\frac{d^2v}{dt^2} = -Kv$ where 'K' is a positive constant. Which of the following statements is correct?

(a) The particle does not perform SHM.
(b) The particle performs SHM with time period $2\pi\sqrt{\frac{m}{K}}$.
(c) The particle performs SHM with frequency $\frac{\sqrt{K}}{2\pi}$.
(d) The particle performs SHM with time period $\frac{2\pi}{K}$.

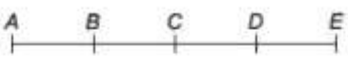
12. A 4 kg particle is moving along the x-axis under the action of the force $F = -\left(\frac{\pi^2}{16}\right)x\,N$. At $t = 2$ sec, the particle passes through the origin and at $t = 10$ sec its speed is $4\sqrt{2}$ m/s. The amplitude of the motion is:

(a) $\frac{32\sqrt{2}}{\pi}$m (b) $\frac{16}{\pi}$m

(c) $\frac{4}{\pi}$m (d) $\frac{16\sqrt{2}}{\pi}$m

13. Which of the following is correct about a SHM, along a straight line?
(a) Ratio of acceleration to velocity is constant.
(b) Ratio of acceleration to potential energy is constant.
(c) Ratio of acceleration to displacement from the mean position is constant.
(d) Ratio of acceleration to kinetic energy is constant.

14. A body performs SHM along the straight line segment *ABCDE* with *C* as the mid point of segment *AE* (*A* and *E* are the extreme position for the SHM). Its kinetic energies at *B* and *D* are each one fourth of its maximum value. If length of segment *AE* is $2R$, then the distance between *B* and *D* is



(a) $\frac{\sqrt{3}}{2}R$ (b) $\frac{R}{\sqrt{2}}$

(c) $\sqrt{3}R$ (d) $\sqrt{2}R$

15. A particle is moving on *x*-axis has potential energy $U = 2 - 20x + 5x^2$ Joules along

x-axis. The particle is released at $x = 3$. The maximum value of '*x*.' will be:

[*x* is in meters and *U* is in joules]
(a) 5 m (b) 3 m
(c) 7 m (d) 8 m

16. The potential energy of a particle executing SHM changes from maximum to minimum in 5 s. Then the time period of SHM is:
(a) 5 s (b) 10 s
(c) 15 s (d) 20 s

17. A particle performs S.H.M. of amplitude *A* along a straight line. When it is at a distance $\frac{\sqrt{3}}{2}A$ from mean position, its kinetic energy gets increased by an amount $\frac{1}{2}m\omega^2A^2$ due to an impulsive force. Then its new amplitude becomes:

(a) $\frac{\sqrt{5}}{2}A$ (b) $\frac{\sqrt{3}}{2}A$

(c) A (d) $\sqrt{2}A$

18. A particle of mass 10 gm is placed in a potential field given by $V = (50x^2 + 100)$ J/kg. The frequency of oscillation in cycle/sec is:

(a) $\frac{10}{\pi}$ (b) $\frac{5}{\pi}$

(c) $\frac{100}{\pi}$ (d) $\frac{50}{\pi}$

19 Which of the following is greatest in SHM (assuming potential energy = 0 at mean position)?
(a) Average kinetic energy with respect to space
(b) Average potential energy with respect to space
(c) Average kinetic energy with respect to time
(d) Average potential energy with respect to time

20. The total mechanical energy of a particle executing simple harmonic motion is *E*. When the displacement is half the amplitude its kinetic energy will be

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

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

21. A particle is executing linear SHM. The average kinetic energy and average potential energy, over a period of oscillation, respectively are K_{av} and U_{av}. Then,

(a) $K_{av} = \frac{U_{av}}{2}$ (b) $U_{av} = \frac{K_{av}}{2}$

(c) $K_{av} = U_{av}$ (d) $U_{av} = \frac{K_{av}}{3}$

22. A linear harmonic oscillator of force constant 2×106 Nm^{-1} and amplitude 0.01 m has a total mechanical energy 160 J. Among the following statements, which are correct?
i. Maximum PE is 100 J
ii. Maximum KE is 100 J
iii. Maximum PE is 160 J
iv. Minimum PE is zero
(a) Both (i) and (iv) (b) Both (ii) and (iii)
(c) Both (i) and (ii) (d) Both (ii) and (iv)

23. A body is executing SHM under the action of a force whose maximum magnitude is 50 N. The magnitude of force acting on the particle at the time when its energy is half kinetic and half-potential is (Assume potential energy to be zero at mean position).

(a) $12.5\sqrt{2}$ N (b) 12.5 N

(c) 25 N (d) $25\sqrt{2}$ N

24. A particle of mass m is executing SHM about the origin on *x*-axis with frequency $\sqrt{\frac{ka}{\pi m}}$, where *k* is a constant and *a* is the amplitude. Find its potential energy, if *x* is the displacement at time *t*:
(a) kax^2 (b) ka^2x
(c) $2\pi kax^2$ (d) $2\pi kx^3$

25. A particle is executing SHM. At a point $x = A/3$, kinetic energy of the particle is K, where A is the amplitude. At a point $x = 2A/3$, kinetic energy of the particle will be:

(a) 2 K (b) $K\sqrt{2}$
(c) $\frac{5}{8}$K (d) $\frac{5}{3}$K

26. The mass of a particle is 1 kg and it is moving along x-axis. The period of its small oscillation is $\frac{\pi}{2}$. Find its potential energy:
(a) $-4 \sin 2x$ (b) $-16 \sin x$
(c) $-16 \cos x$ (d) $-4 \cos 2x$

27. The frequency of oscillation is $\left(\frac{10}{\pi}\right)$ (in Hz) of a particle of mass 0.1 kg which executes SHM along x-axis. The kinetic energy is 0.3 J and potential energy is 0.2J at position $x = 0.02$ m. The potential energy is zero at mean position. Find the amplitude of oscillations (in meters):

(a) $\frac{1}{2\sqrt{10}}$ (b) $\frac{1}{\sqrt{10}}$
(c) $\sqrt{10}$ (d) $2\sqrt{10}$

28. In a simple harmonic motion of a particle, potential energy at mean position is 4 J and at extreme position is 20 J. Given that amplitude of oscillation is A, where U is potential energy and K is kinetic energy and $x = 0$ is mean position.

	Column-I		Column-II
i.	$(U)_{at\ x=\frac{A}{2}}$	p.	18 J
ii.	$(K)_{at\ x=\frac{A}{4}}$	q.	16 J
iii.	$(K)_{at\ x=0}$	r.	8 J
iv.	$(K)_{at\ x=\frac{A}{2}}$	s.	None of the above

Now, match the given columns and select the correct option from the codes given below.

Codes
(a) i – p, ii – q, iii – r, iv – s
(b) i – q, ii – q, iii – p, iv – s
(c) i – s, ii – s, iii – p, iv – s
(d) i – q, ii – p, iii – r, iv – p

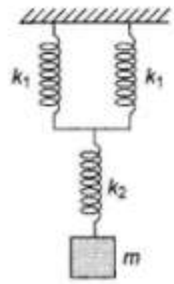
Spring Particle System

29. If a spring balance having frequency f is taken on moon (having $g' = g/6$) it will have a frequency of:

(a) $6f$ (b) $\frac{f}{3}$
(c) $\frac{f}{6}$ (d) $3f$

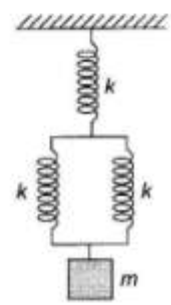
30. An object is attached to the bottom of a light vertical spring and set vibrating. The maximum speed of the object is 15 cm/sec and the time in centimeters is:
(a) 3.0 (b) 2.0
(c) 1.5 (d) 1.0

31. What will be the force constant of the spring system shown in the figure?



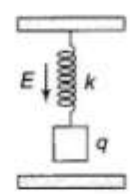
(a) $\left[\frac{1}{k_1}+\frac{1}{k_2}\right]$ (b) $\left[\frac{1}{2k_1}+\frac{1}{k_2}\right]^{-1}$
(c) $\left[\frac{1}{k_1}+\frac{1}{k_2}\right]^{-1}$ (d) $\left[\frac{1}{2k_1}+\frac{1}{k_2}\right]$

32. What will be time period of the displaced body of mass m?



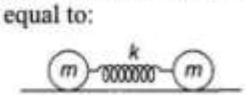
(a) $2\pi\sqrt{\frac{m}{2k}}$
(b) $2\pi\sqrt{\frac{3m}{k}}$
(c) $2\pi\sqrt{\frac{3m}{2k}}$
(d) $\pi\sqrt{\frac{3m}{k}}$

33. Time period of a block when suspended from the upper plate of a parallel plate capacitor by a spring of stiffness k, is T; when block is uncharged. If a charge q is given to the block then new time period of oscillation will be:



(a) T (b) $> T$
(c) $< T$ (d) $\geq T$

34. Two identical particles each of mass m are interconnected by a light spring of stiffness k, the time period for small oscillation is equal to:



(a) 250 (b) 252
(c) 260 (d) 262

35. The frequencies of two sound sources are 256 Hz and 260 Hz. At $t = 0$, the intensity of sound is maximum. Then the phase difference at the time $t = 1/16$ sec will be
(a) Zero (b) π
(c) $\pi/2$ (d) $\pi/4$

36. 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

37. 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

38. 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

39. 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

40. Ten tuning forks are arranged in increasing order of frequency in such a way that any two nearest tuning forks produce 4 beats/sec. The highest frequency is twice of the lowest. Possible highest and the lowest frequencies are
(a) 80 and 40 (b) 100 and 50
(c) 44 and 22 (d) 72 and 36

41. Two identical flutes produce fundamental notes of frequency 300 Hz at 27°C. If the temperature of air in one flute is increased to 31°C, the number of the beats heard per second will be
(a) 1 (b) 2
(c) 3 (d) 4

42. 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

43. Two tuning forks have frequencies 380 and 384 Hz respectively. When they are sounded together, they produce 4 beats. After hearing the maximum sound, how long will it take to hear the minimum sound
(a) $\frac{1}{2}$ sec (b) $\frac{1}{4}$ sec
(c) $\frac{1}{8}$ sec (d) $\frac{1}{16}$ sec

44. 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

45. 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}

46. Two tuning forks of frequency 250 Hz and 256 Hz produce beats. If a maximum is observed just now, after how much time the next maximum is observed at the same place?
(a) 1/18 sec (b) 1/24 sec
(c) 1/6 sec (d) 1/12 sec

47. At a point, beats frequency of n Hz is observed. It means:
(a) medium particles, at that point, are vibrating with frequency n Hz
(b) amplitude of vibrations changes simple harmonically with frequency n Hz at that point only
(c) at that, zero intensity is observed $2n$ times per second
(d) none of the above

48. When beats are produced by two progressive waves of nearly the same frequency, which one of the following is correct?
(a) The particles vibrate simple harmonically, with the frequency equal to the difference in the component frequencies.
(b) The amplitude of vibration at any point changes simple harmonically with a frequency equal to the difference in the frequencies of the two waves.
(c) The frequency of beats depends upon the position, where the observer is.
(d) The frequency of beats changes as the time progresses.

49. When two tuning forks A and B are sounded together x beat/s are heard. Frequency A is n. Now, when one prong of B is loaded with a little wax, the number of beats/s decreases. The frequency of fork B is

(a) kinetic energy only
(b) potential energy only
(c) kinetic energy as well as potential energy
(d) none of these

50. There are 10 sound sources each producing intensity I at a point independently. They are incoherent. Average intensity of sound at that point will be:
(a) I (b) $10I$
(c) $100I$ (d) 0

51. Two coherent sources of different intensities send waves which interfere. The ratio of the maximum intensity to the minimum intensity is 25. The intensities are in the ratio:
(a) 25: 1 (b) 5: 1
(c) 9: 4 (d) 625: 1

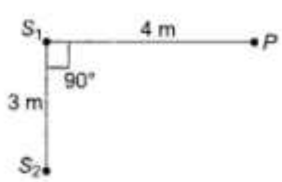
52. A string fixed at both ends has consecutive standing wave modes for which the distances between adjacent nodes are 18 cm and 16 cm respectively. The minimum possible length of the string is
(a) 144 cm (b) 152 cm
(c) 176 cm (d) 200 cm

53. When a wave pulse travelling in a string is reflected from a rigid wall to which string is tied as shown in figure. For this situation two statements are given below.

(1) The reflected pulse will be in same orientation of incident pulse due to a phase change of π radians
(2) During reflection the wall exert a force on string in upward direction

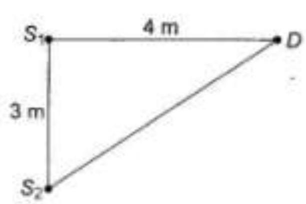
For the above given two statements choose the correct option given below.
(a) Only (1) is true (b) Only (2) is true
(c) Both are true (d) Both are wrong

54. S_1 and S_2 are two coherent sources of sound of frequency 110 Hz each. They have no initial phase difference. The intensity at a point P due to S_1 is I_0 and due to S_2 is $4I_0$. If the velocity of sound is 330 m/s then the resultant intensity at P is



(a) I_0 (b) $9I_0$
(c) $3I_0$ (d) $8I_0$

55. In the figure the intensity of waves arriving at D from two coherent sources S_1 and S_2 is I_0. The wavelength of the wave is $\lambda = 4$ m. Resultant intensity at D will be:

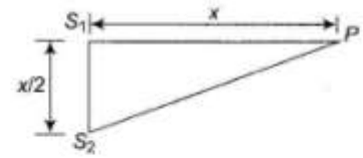


(a) $4I_0$ (b) I_0
(c) $2I_0$ (d) zero

56. Two interfering waves have intensities in the ratio 9: 1. Then the ratio of maximum to maximum intensity is:
(a) 10: 8 (b) 4: 2
(c) 100: 64 (d) 16: 4

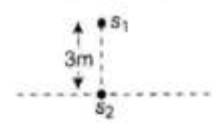
57. The difference of loudness in decibels (dB) between maximum and minimum intensities of two coherent sound sources as they interfere in space is 20 log 3. Find the ratio of intensities of two coherent sound sources:
(a) 2 (b) 4
(c) $4\sqrt{2}$ (d) 8

58. The wavelength of the waves arriving at P from two coherent sources S_1 and S_2 is 4m, while intensity of each wave is I_0. The resultant intensity at P is $2I_0$. Find the minimum value of S_2P:



(a) $\frac{x\sqrt{5}}{2}$ (b) $2x$
(c) $(x+1)$ (d) $(x+\sqrt{2})$

59. S_1 and S_2 are two coherent sources of sound having no initial phase difference. The velocity of sound is 330 m/s. No minima will be formed on the line passing through S_2 and perpendicular to the line joining S_1 and S_2, if the frequency of both the sources is:



(a) 50 Hz (b) 60 Hz
(c) 70 Hz (d) 80 Hz

Beats

60. An unknown frequency x produces 8 beats per seconds with a frequency of 250 Hz and 12 beats with 270 Hz source, then x is
(a) 258 Hz (b) 242 Hz
(c) 262 Hz (d) 282 Hz

61. 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

62. 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

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

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

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

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)

. 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) $1.2f$, 1.2λ

63. The amplitude of a wave represented by displacement equation $y = \frac{1}{\sqrt{a}}\sin\omega t \pm \frac{1}{\sqrt{b}}\cos\omega t$ will be

(a) $\frac{a+b}{ab}$ (b) $\frac{\sqrt{a}+\sqrt{b}}{ab}$
(c) $\frac{\sqrt{a}\pm\sqrt{b}}{ab}$ (d) $\sqrt{\frac{a+b}{ab}}$

64. Two waves having equations

$$x_1 = a\sin(\omega t + \varphi_1),\ x_2 = a\sin(\omega t + \varphi_2)$$

If in the resultant wave the frequency and amplitude remain equal to those of superimposing waves. Then phase difference between them is

(a) $\frac{\pi}{6}$ (b) $\frac{2\pi}{3}$
(c) $\frac{\pi}{4}$ (d) $\frac{\pi}{3}$

65. A travelling wave y = $A\sin(kx - \omega t + \theta)$ passes from a heavier string to a lighter string. The reflected wave has amplitude 0.5 A. The junction of the strings is at $x = 0$. The equation of the reflected wave is:

(a) $y' = 0.5A\sin(kx + \omega t + \theta)$
(b) $y' = -0.5A\sin(kx + \omega t + \theta)$
(c) $y' = -0.5A\sin(\omega t - kx - \theta)$
(d) $y' = 0.5A\sin(kx + \omega t - \theta)$

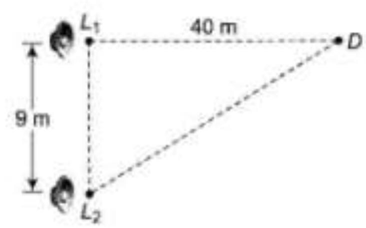
66. In a large room, a person receives direct sound waves from a source 120 metres away from him. He also receives waves from the same source which reach him, being reflected from the 25 metre high ceiling at a point halfway between them. The two waves interfere constructively for wavelength of

(a) 20, 20/3, 20/5 etc.   (b) 10, 5, 2.5 etc.
(c) 10, 20, 30 etc.   (d) 15, 25, 35 etc.

67. Two speakers connected to the same source of fixed frequency are placed 2.0 m apart in a box. A sensitive microphone placed at a distance of 4.0 m from their midpoint along the perpendicular bisector shows maximum response. The box is slowly rotated until the speakers are in line with the microphone. The distance between the midpoint of the speakers and the microphone remains unchanged. Exactly five maximum responses are observed in the microphone in doing this. The wavelength of the sound wave is

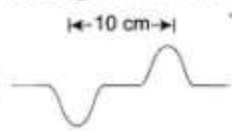
(a) 0.2 m   (b) 0.4 m
(c) 0.6 m   (d) 0.8 m

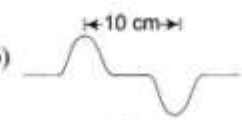
68. Two loudspeakers L_1 and L_2 driven by a common oscillator and amplifier, are arranged as shown. The frequency of the oscillator is gradually increased from zero and the detector at D records a series of maxima and minima. If the speed of sound is 330 ms^{-1} then the frequency at which the first maximum is observed is



(a) 165 Hz   (b) 330 Hz
(c) 496 Hz   (d) 660 Hz

69. Two pulses travel in mutually opposite directions in a string with a speed of 2.5 cm/s as shown in the figure. Initially the pulses are 10 cm apart. What will be the state of the string after two seconds?

(a) 

(b) 

(c)
(d)