PHYSICS **Max Marks: 80**

SECTION – I
(SINGLE CORRECT CHOICE TYPE)

This section contains **7 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

24. A sound source is moving with uniform speed along a curve y = A sin kx in x-y plane: Where x and y are the coordinates of the source. Three detectors are placed at $\left(\frac{\pi}{2k},-10A\right),\left(\frac{\pi}{2k},0\right) and \left(\frac{\pi}{2k},10A\right)$. At the instant when the sound source crosses the point $\left(\frac{\pi}{2k},A\right)$, the frequency registered by detectors are f_1,f_2,f_3 . If the waves detected are corresponding to the positions of source - $0<x<\pi/2k$, then:

A) $f_1>f_2>f_3$ B) $f_1<f_2<f_3$ C) $f_1=f_2=f_3$ D) $f_2=\frac{f_1+f_3}{2}$

25. The superposition of two waves travelling in opposite directions given by the equations: $y_1=a\sin(\omega t-kx)$ and $y_2=2a\sin(\omega t+kx)$ Takes place in a homogeneous string of cross section area s and density ρ. The resulting pattern can be thought as a superposition of a standing wave and progressive wave travelling left. The total mechanical energy between two successive antinodes is:

A) $\frac{3\pi s\rho\omega^2a^2}{2k}$ B) $\frac{\pi s\rho\omega^2a^2}{2k}$ C) $\frac{5\pi s\rho\omega^2a^2}{2k}$ D) $\frac{\pi s\rho\omega^2a^2}{k}$

26. A rope hangs from a rigid support. A pulse is set by jiggling the bottom end. We want to design a rope in which velocity υ of pulse is independent of z, the distance of the pulse from fixed end of the rope. If the rope is very long with negligible linear mass density near the free end. The desired function for mass per unit length $\mu(z)$ in terms of μ_0 (mass per unit length of the rope at the top (z = 0) is given by

A) $\mu(z) = \mu_0 e^{-\frac{gz}{v^2}}$

B) $\mu(z) = \mu_0 e^{-\frac{gz^2}{v^2}}$

C) $\mu(z) = \mu_0 \log_e\left(\frac{g}{\upsilon^2}\right) z$

D) $\mu(z) = \mu_0 e^{-\left(\frac{\upsilon^2}{gz}\right)}$

27. When beats are produced by two sinusoidal progressive waves of nearly the same frequency, which one of the following three statements A,B,C is correct. Mark D if all three statements are incorrect.

A) The particles vibrate simple harmonically, with the frequency equal to the difference in the component frequencies.

B) The amplitude of vibrations at any point change simple harmonically with a frequency equal to the difference in the frequencies of the two waves.

C) The frequency of the beats depends on the position, where the observer is situated.

D) None of the above statements are correct.

28. Two sounding bodies producing progressive waves given by $y_1 = 4\sin 400\pi t$ and $y_2 = 3\sin 404\pi t$ are situated very near to the ears of a person on opposite sides of him.

He will hear

A) 2 beats per second with intensity ratio (7/1) between maxima and minima

B) 2 beats per second with intensity ratio (49/1) between maxima and minima

C) 4 beats per second with intensity ratio (7/1) between maxima and minima

D) 4 beats per second with intensity ratio (49/1) between maxima and minima

29. Choose the incorrect statement about transverse and longitudinal waves out of the three statements A,B,C given below. Mark D if none of the three statements are incorrect

A) Longitudinal waves can propagate through all the forms of matter.

B) Transverse waves can never propagate through air or any other gas.

C) Transverse waves can never propagate inside the body or surface of a liquid.

D) None of the above are incorrect

30. Choose the incorrect statements about the standing waves out of the three statements A,B,C given below. Mark D if none of the three statements are incorrect

A) There are certain points in the medium which have zero displacement at all instants, or there are certain points in the medium which have their maximum possible displacement at all instants.

B) There are certain points in the medium which have zero displacement at all instants, and there are certain points in the medium which have their maximum possible displacement at all instants.

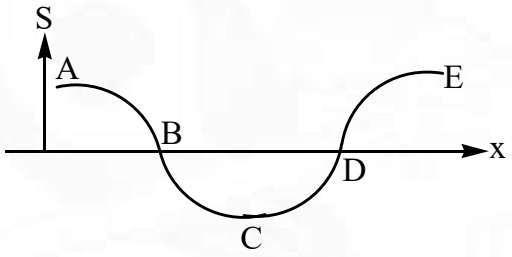
C) There exists an instant when all parts of the medium have zero displacement, or there exists an instant when all parts of the medium have non-zero displacement

D) None of the above are incorrect

SECTION – II
(MULTIPLE CORRECT CHOICE TYPE)

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/ are correct

31. The figure represents bulk strain *S* versus position x graph for a plane progressive longitudinal wave propagating in a long metal bar in negative x – direction at an instant of time . Then at that instant,



A) part ABC represents region of compression

B) part CDE represents region of rarefaction

C) part BCD represents region of compression

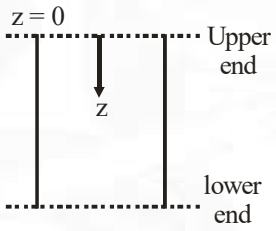
D) part BCD represents region of rarefaction

32. In an organ pipe (which may be closed or open) of 99 cm length, longitudinal standing wave is set up whose equation is given by longitudinal displacement,

$$x = 0.3 \text{ mm} \cos\frac{2\pi}{0.8}(Z + 0.01)\cos 400t$$

where z is measured from the top of tube in metres and t is in seconds.

Take end correction = 1 cm, choose the correct statements.



A) The upper and lower end of tube are open and closed respectively

B) The upper end and lower end of tube are closed and open respectively

C) The air column is vibrating in third harmonic

D) The air column is vibrating in second overtone

33. In which of the following cases, will the power being delivered by the given progressive sinusoidal wave to the string is doubled? Assume material of the string is unchanged, and any variable not mentioned in the options are unchanged.

A) Wave amplitude is doubled while wave frequency is cut to half.

B) The diameter of the string is doubled, while stress in it remains unchanged.

C) Stress in the string is made four times the initial value.

D) The diameter of the string is doubled, while stress in it is cut to a quarter of initial value.

34. fig. 1 shows the photograph of a wave traveling on a long string taken at some instant & Fig. 2 shows the snap of a standing wave pattern on a string at the instant when all medium particles are at their extremes. A, B, C, D represent small portions of the string at the respective points.

Fig I:

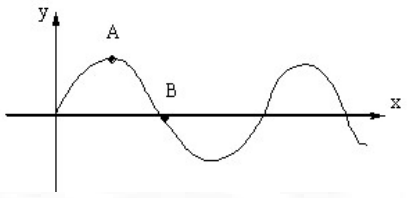
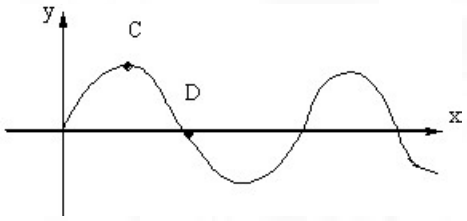


Fig II:



A) Potential energy at A is maximum, while Kinetic energy at C is zero.

B) Potential energy at B is maximum, while Kinetic energy at D is zero

C) Potential energy at D is maximum, while Kinetic energy at A is zero

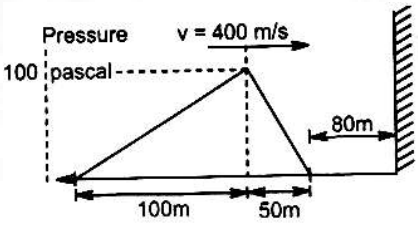
D) Potential energy at C is maximum, while Kinetic energy at B is zero

SECTION – III
(COMPREHENSION TYPE)

This section contains 2 groups of questions. Each group has 2&3 multiple choice questions based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Questions Nos. 35 to 37

A large plane pressure pulse, whose P Vs x graph is triangular in shape, approaches a rigid wall normal to it, at a speed of 400m/s. At time t = 0, situation is shown in the figure. The peak pressure is 100Pa. The pulse gets reflected by the wall and pressure near the wall gets doubled. Height of the wall is 2 m and width is also 2m. A detector on the wall is designed to measure gauge pressures between 32 Pascal and 184 pascal, and it does not detect a gauge pressure out of this range.



35. When will the detector detect the pressure pulse for the first time?

A) 210ms B) 220ms C) 230 ms D) 240ms

36. For how long, will the detector will record the pulse?

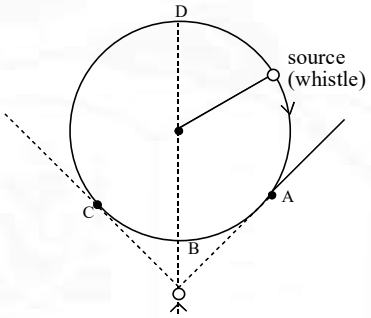
A) 255ms B) 285ms C) 315ms D) 345ms

37. What is the total impulse imparted by the pulse on the wall ?

A) 300 Ns B) 150Ns C) 750 Ns D) 75Ns

Paragraph for Questions Nos. 38 to 39

A whistle emitting sound of frequency f_0 is in uniform circular motion in clockwise sense as shown. A, B, C, D are points on its path as shown. frequency observed by observer shown in the diagram is f.



38. For which of the following portion of the path of source is $f > f_0$

A) DAB B) CDA C)ABC D) BCD

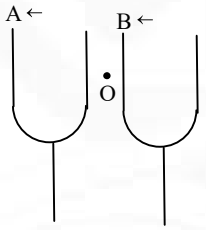
39. For which of the following portion of the path of source is f increasing

A) BAD B) CDA C)ABC D) BCD

SECTION –IV
(INTEGER ANSWER TYPE)

This section contains 7 questions . The answer to each of the questions is a single digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened.

40. Two tuning forks A and B each of natural frequency 85 Hz move with velocity 10m/s relative to stationary observer 'O'. Fork A moves away from the observer while the fork B moves towards him as shown in the figure. A wind is blowing with a speed 10 m/s in the direction of motion of fork A. Find the beat frequency measured by the observer in Hz. [Take speed of sound in air as 340 m/s]

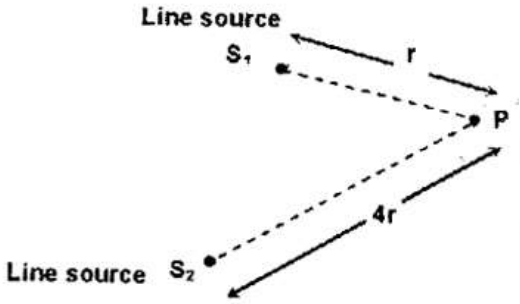


41. Two metallic strings A and B made of different materials are connected in series forming a joint. The strings have similar cross-sectional area. The length of A is $l_A = 0.3$ m and that B is $l_B = 0.75\,\text{m}$. One end of the combined string is tied with a support rigidly and the other end is loaded with a block of mass m passing over a frictionless pulley. Transverse waves are set up in the combined string using an external source of variable frequency, then at the lowest frequency standing waves are observed such that the joint is a node. The total number of nodes and antinodes on the strings is 10+b . Find b (the densities of A and B are $6.3\times10^3 kg/m^3$ and $2.8\times10^3 kg/m^3$, respectively).

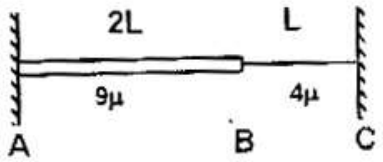
42. A listener moving with uniform velocity towards a stationary sound source hears a beep of sound of frequency v=170 Hz over a distance x = 80m. If the frequency of sound emitted by the source is $v_o = 160Hz$ and sound travels with speed c = 340 m/s, find duration of the beep emitted by the source in seconds. [Round off to the nearest integer.]

43. In the experiment for the determination of the speed of sound in air using the resonance column method, the length of the air column that resonates in the fundamental mode, with a turning fork is 0.1 m. When this length is changed to 0.35 m, the same tuning fork resonates with the first overtone. The end correction is $5P$ mm, find P.

44. Intensity due to a line source S_1 at a distance of r is I_0 and intensity due to other line source S_2 at a distance of r is $4I_0$ and frequency of both source are equal. If interference occurs at a point P as shown in the figure and wavelength of both sources is r, find the resultant intensity (in watt/m^2) at P. (where I_0 = 1 watt/m^2)



45. A thick rope of length 2L and linear mass density 9μ is joined at B to a thin rope of length L and linear mass density 4μ. The system is horizontally stretched by the two vertical walls A and C. Assuming B to be a node, find the minimum number of loops in the thick rope.



46. In uniform string a plane transverse harmonic wave propagates. The energy density at a point, when the particle element is in mean position at t = 0 is U_0. If the energy density at same point at $t = \frac{5T}{12}$ is $\frac{nU_0}{8}$. Find the value of n.