# CLASS TEST

PHYSICS CLASS TEST # 72

## SECTION-I

**Single Correct Answer Type** **6 Q. [3 M (–1)]**

**1.** A boy is running in a stadium shaped in form of circle of radius 100 m. At the centre of stadium on ground a loudspeaker emits waves of frequency 165 Hz. The ceiling of stadium is 5 m high. Waves coming directly from speaker and after one reflection from ceiling interfere. What are possible radii of boy's running circle so that he hears maximum sound. $v_{sound}$ = 330 m/s.

(A) $\left[x = \frac{25-2n^2}{2n}\right]$ n = 1, 2, 3, 4 (B) $\left[x = \frac{50-2n^2}{4n}\right]$ n = 1, 2, 3, 4

(C) $\left[x = \frac{50-4n^2}{4n}\right]$ n = 1, 2, 3, 4 (D) $\left[x = \frac{100-4n^2}{4n}\right]$ n = 1, 2, 3, 4

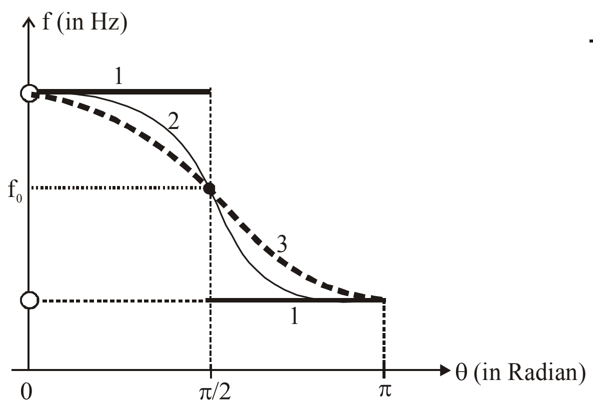
**2.** A student is performing the experiment of Resonance Column. The diameter of the column tube is $\frac{20}{3}$ cm. The frequency of the tuning fork is 1050 Hz. The air temperature is 38°C in which the speed of sound is 336 m/s. The zero of the meter scale coincides with the top end of the Resonance column tube. When the first resonance occurs, the reading of the water level in the column is

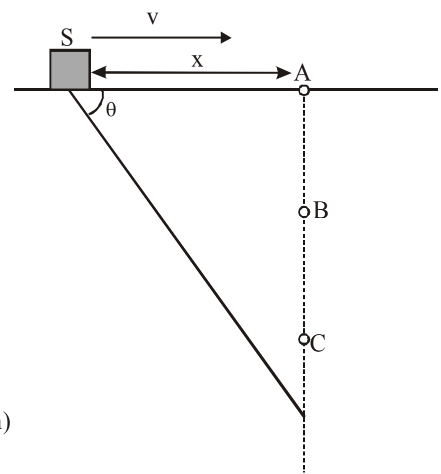
(A) 8 cm (B) 10 cm (C) 6 cm (D) 12 cm

**3.** A pipe open at the top end is held vertically with some of its lower protion dipped in water. At a certain depth of immersion, the air column of length 3/8 m in the pipe resonates with a tuning fork of frequency 680 Hz. The speed of sound in air is 340 m/s. The pipe is now raised up by a distance 'x' until it resonates in the 'next overtone' with the same tuning fork. The value of 'x' is

(A) 20 cm (B) 40 cm (C) 50 cm (D) 25 cm

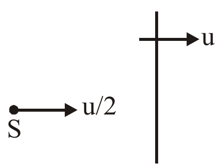
**4.** A source is moving with a constant speed u on a straight line, emitting a sound of frequency $f_0$. There are three observers A, B and C. A on track, B at a perpendicular distance of d from the track and C at a perpendicular distance of 2d form the track as shown in the figure. The variation of the observed frequency with respect to the position x,




(A) A – 3, B – 2, C – 1 (B) A – 2, B – 3, C– 1 (C) A – 1, B – 2, C – 3 (D) A – 1, B – 3, C – 2

**5.** A wall is moving with velocity u and a source of sound moves with velocity u/2 in the same direction as shown in figure. Assuming that the sound travels with velocity 10 u. The ratio of incident sound wavelength on the wall to the reflected sound wavelength by the wall, is equal to (assume observer for reflected sound is at rest) :



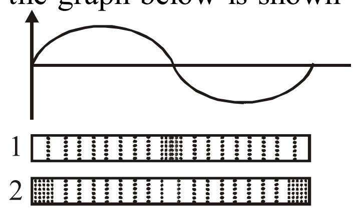

(A) 9 : 11 (B) 11 : 19 (C) 4 : 5 (D) 5 : 4

**6.** Three musicians experiment with the Doppler effect. Musician A rides in a car at a speed u directly away from musician B who is stationary. Musician C rides in a car directly toward B and travels at the same speed as A. Musician A plays a note at frequency $f_A$ on his trumpet. B hears the note, adjusts his trumpet, and plays the same note he heard. Choose the incorrect statement :


(A) The note heard by C coming from B will be the same pitch as $f_A$.
(B) The note heard by A coming from B will be higher in pitch than $f_A$.
(C) The note heard by A coming from B will be lower in pitch than $f_A$.
(D) The note heard by B coming from A will be lower in pitch than $f_A$.

## Multiple Correct Answer Type 4 Q. [4 M (–1)]

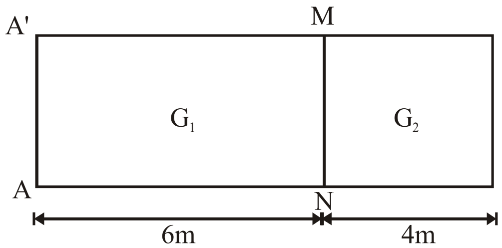
**7.** Displacement vs position graph is shown for a longitudinal wave. In the graph below is shown pressure profile of medium. Choose the **CORRECT** option(s) :-




(A) If wave is moving towards right then pressure profile is 2
(B) If wave is moving towards left then pressure profile is 2
(C) If wave is moving towards right then pressure profile is 1
(D) If wave is moving towards left then pressure profile is 1

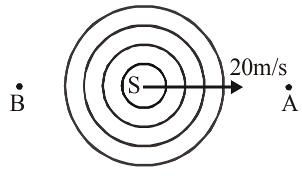
**8.** Which of the following statements is/are valid?
(A) The sound waves from two tuning forks of the same frequency will interfere constructively at some points.
(B) Two waves, A and B, have the same wave velocity. If A has a higher frequency than B, then A will have a shorter wavelength
(C) In a transverse wave, the motion of the particle of the medium is in the same direction as the wave velocity.
(D) The propagation speed (or wave velocity) of a wave can be found by dividing its wavelength by its period.

**9.** Figure shows a closed pipe (closed at both ends) of length 10m. MN is a membrane (thin sheet) capable of doing simple harmonic motion of amplitude 1mm along left and right from shown situation. On two sides of membrane are two gases $G_1$ and $G_2$ in which sound can travel at 300 m/s and 100 m/s respectively.




(A) If resonance is obtained in right side ($G_2$), side ($G_1$) might not resonate.
(B) Resonance in both gases will be possible for some specific frequencies only.
(C) For angular frequency 75 π rad/sec., a particle, $\frac{2}{3}$m right of AA' would be oscillating with maximum displacement 0.5 mm.
(D) For angular frequency 75 π rad/sec., a particle, $\frac{2}{3}$m right of AA' would be oscillating with maximum displacement $\frac{\sqrt{3}}{2}$ mm.

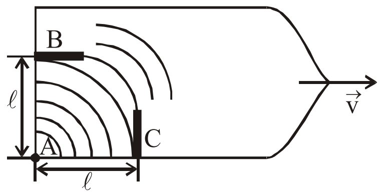
**10.** A sound source S moves with speed of 20 m/s with respect to the medium. There are two detectors A & B located as shown in figure. If wavelength emitted by source are in the range of 20 to 50 cm then choose correct statement(s) :-




(A) A wavelength detected by A may be 20 cm, 30 cm, 50 cm
(B) A wavelength detected by A may be 19 cm, 30 cm, 41 cm
(C) A wavelength detected by B may be 20 cm, 30 cm, 50 cm
(D) A wavelength detected by B may be 22 cm, 51 cm, 53 cm

## Linked Comprehension Type (1 Para × 2Q.) [3 M (-1)]
## (Single Correct Answer Type)

**Paragraph for Questions 11 and 12**




A ship swims at constant velocity $\vec{v}$ on a windless ocean. A short sound pulse is emitted from a sound source located at point A of the open deck of the ship, the speed of sound is $v_0$. The sound is reflected from wall B that is at distance $\ell$ from point A and is parallel to the direction of travel. The sound is also reflected from wall C that is also at distance $\ell$ but is perpendicular to the direction of travel. The sound reflected from wall B is received at A after time $t_B$ and similarly from wall C after time $t_C$.

**11.** If $t_B = nt_C$, then the ratio of $\frac{v_0}{v}$ would be

(A) $\frac{1}{n}$ (B) $\frac{1}{\sqrt{n}}$ (C) $\frac{1}{\sqrt{1-n^2}}$ (D) $\frac{1}{1-n^2}$

**12.** If rather then pulse, a continuous sound wave of frequency f is produced by source, then the beat frequency as observed by an observer at A would be

(A) $\frac{f}{n^2}$ (B) $\frac{f}{1-n^2}$ (C) $\frac{f}{n}$ (D) None of these

## Linked Comprehension Type (1 Para × 3 Q.) [4 M (–1)]
## (Multiple Correct Answer Type)

**Paragraph for Q. No. 13 to 15**

Figure shows a cylinder piston arrangement in which a piston is moved.

For molecules striking the piston, the speed of approach is = $v_p + v_m$.

Speed of separation is = $v_m + 2v_p$ after striking the piston.

As shown in figure each molecule that strikes the moving piston has the quantity $2v_p$ added to its speed. Thus, kinetic energy is added to the gas.

An identical molecule moving at $v_m$ towards the piston that strikes head-on another molecule moving away from the piston with speed $v_m + 2v_p$. The one originally moving toward the piston with velocity $v_m$ now moves away with velocity $v_m + 2v_p$, and the other molecule heads back toward the piston with speed $v_m$. The net result of all this collision is that the excess velocity $2v_p$ is passed on from one molecule to the next. The rightmost molecule with the extra velocity is at the leading edge of a propagating disturbance as shown in figure. If we look within the disturbed region, at any given moment we can expect that half the molecules have velocity $-v_m$ toward the piston and half have velocity $+v_m + 2v_p$ away from the piston as shown in figure (b). When the piston stops moving, the molecules returning to it with speed $v_m$ simply have their velocities reversed, and we are back where we started, except for the propagating disturbance, which is now traveling down the tube with a speed of $v_m + 2v_p \approx v_m$. In the disturbed region the gas molecules have excess average speed $v_p$, but that region of excess speed propagates with much higher speed $v_m$. A compressed region is formed whenever the piston is pushed into the tube. A rarefactions region is formed whenever the piston is pushed back into the tube. As the piston oscillates sinusoidally, regions of compression and rarefaction are continuously set up. The pressure variation is a maximum when the displacement from equilibrium is zero, and the displacement from equilibrium is a maximum when the pressure variation is zero.

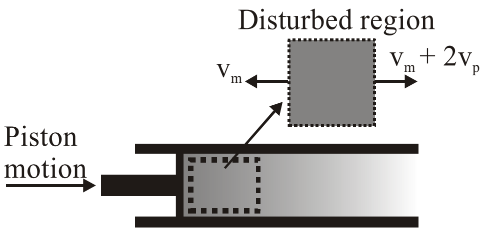



**Figure (a)**

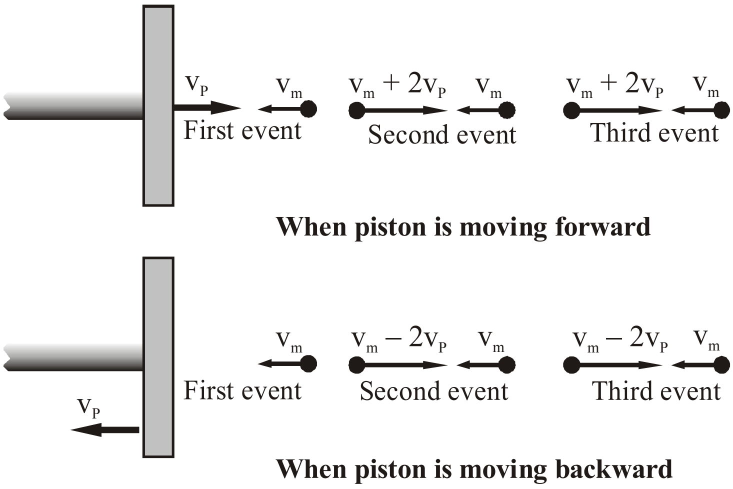



**Figure (b)**

**13.** Consider for the case piston is pushed inward. Mark the **CORRECT** statement(s) :-

(A) The gas in the region between the piston and the leading edge of the disturbance has acquired an average velocity $v_p$ to the right

(B) Each gas molecule hit by the piston gains velocity $2v_p$ in the x-direction, thus increasing the kinetic energy of the gas.

(C) Extra kinetic energy is passed on from molecule to molecule at roughly the speed $v_m$ which is much faster than the piston speed $v_p$

(D) The molecules that were pushed out of the way by the piston also create a region of increased density that itself also propagates down the tube along with the excess kinetic energy.

**14.** Mark the **CORRECT** statement(s) :-

(A) A compressed region is formed whenever the piston is pushed into the tube. This compressed region, moves through the tube with speed of sound in the medium.

(B) A rarefaction region is formed whenever the piston is pushed back into the tube. This rarefaction region also moves through the tube with speed of sound in the medium.

(C) When a compressed region is formed density of the medium increases.

(D) When a rarefaction region is formed density of the medium decreases.

**15.** Consider that piston oscillates to and fro in simple harmonic motion. Mark the **CORRECT** statement(s) about longitudinal pressure wave.

(A) The density variation of the particles have their maxima and minima at the position of equilibrium of the particles.

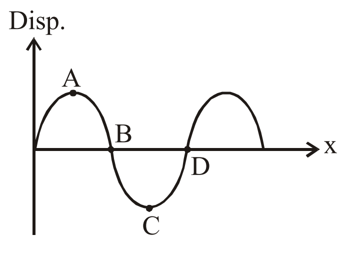
(B) At the position of maximum displacement of particles the density is at the ambient (environment) value.

(C) Greatest compression occurs at the same time and place where the velocity of the particles is maximum and in direction of wave propagation.

(D) Greatest rarefaction occurs at the same time and place where the velocity of the particles is maximum and in direction of wave propagation.

## Matching List Type (4 × 4) 1Q.[3 M (–1)]

**16.** Figure shows displacement vs x-graph for a longitudinal wave at time t travelling along +x-direction.




| List-I | | List-II | |
|---|---|---|---|
| (P) | Point A | (1) | Maximum pressure |
| (Q) | Point B | (2) | Minimum pressure |
| (R) | Point C | (3) | Acceleration positive |
| (S) | Point D | (4) | Acceleration negative |

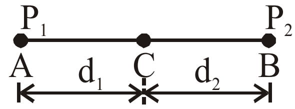
**Code :-**

| | P | Q | R | S |
|---|---|---|---|---|
| (A) | 4 | 1 | 3 | 2 |
| (B) | 1 | 3 | 2 | 4 |
| (C) | 2 | 3 | 1 | 4 |
| (D) | 4 | 1 | 2 | 3 |

## SECTION-III

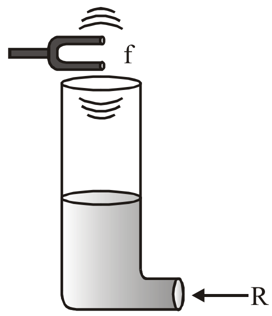
**Numerical Grid Type (Ranging from 0 to 9) 3 Q. [4 M (0)]**

**1.** As shown in the figure, two loudspeakers are located at point A and B. Both are vibrating in phase at a frequency ν 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 W/m$^2$) at point C. Take velocity of sound = 300 ms$^{-1}$, frequency ν = 100 Hz, $d_1$ = 1m and $d_2$ = 1.5 m, $P_1$ = 8π watts and $P_2$ = 18 π watts. Also assume that loudspeakers behave like isotropic sources. (emit sound uniformly in all directions).




**2.** A source plays a tone with frequency $f_0$ = 440 Hz. What is the speed of a car moving straight towards the source, if the driver hears a frequency of 462 Hz. If your answer is $v_0$ (in m/s) then fill value of $\frac{v_0 + 1}{2}$. (Speed of sound in the air is v = 340 ms$^{-1}$, the effects of the material of the car can be neglected)

**3.** As shown in figure water is pumped into a tall vertical cylinder at a volume flow rate R. The radius of the cylinder is r, and at the open top of the cylinder a tuning fork is vibrating with a frequency f. As the water rises, time interval elapse between successive resonances is given by $t = \frac{\pi r^2}{R}\frac{v}{\alpha f}$ where v is speed of sound in air. Find α.

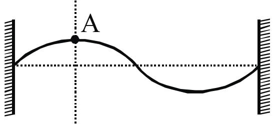



## SECTION-IV

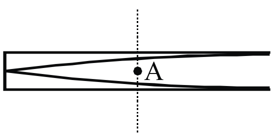
**Matrix Match Type (4 × 5) 1 Q. [8 M (for each entry +2(0)]**

**1.** **Column I** shows four systems, for producing standing waves. Match each system with statements given in **Column II** describing the nature and different parameters of the standing waves.

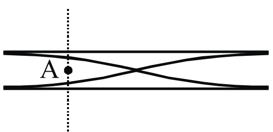
**Column I** **Column II**

(A) 

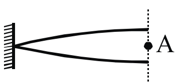

(P) Longitudinal standing wave

(B) 


(Q) Transverse standing wave

(C) 


(R) Power transfer can take place across point A

(D) 


(S) All overtones are possible

(T) KE of particle A is always zero

**CLASS TEST # 72** **ANSWER KEY**

## SECTION-I

**Single Correct Answer Type** **6 Q. [3 M (–1)]**

**1. Ans. (D)** **2. Ans. (C)** **3. Ans. (D)** **4. Ans. (C)** **5. Ans. (A)** **6. Ans. (B)**

**Multiple Correct Answer Type** **4 Q. [4 M (–1)]**

**7. Ans. (C, D)** **8. Ans. (A, B, D)** **9. Ans. (A,C)** **10. Ans. (B, D)**

**Linked Comprehension Type** **(1 Para × 2Q.)** **[3 M (-1)]**
**(Single Correct Answer Type)**

**11. Ans. (C)** **12. Ans. (D)**

**Linked Comprehension Type** **(1 Para × 3 Q.)** **[4 M (–1)]**
**(Multiple Correct Answer Type)**

**13. Ans. (A, B, C, D)** **14. Ans. (A, B, C, D)** **15. Ans. (A, B, C)**

**Matching List Type (4 × 4)** **1Q.[3 M (–1)]**

**16. Ans. (A)**

## SECTION-III

**Numerical Grid Type (Ranging from 0 to 9)** **3 Q. [4 M (0)]**

**1. Ans. 6** **2. Ans. 9** **3. Ans. 2**

## SECTION-IV

**Matrix Match Type (4 × 5)** **1 Q. [8 M (for each entry +2(0)]**

**1. Ans. (A) QRS (B) PRS (C) PRS (D) QRS**