DPP – 2 (Sound Wave)

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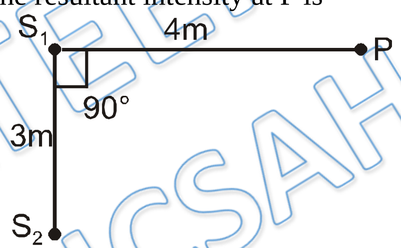
Written Solution on Website:-	https://physicsaholics.com/note/notesDetalis/45

Q 1. In Quincke's tube a detector detects minimum intensity. Now one of the tubes is displaced by 5 cm. During displacement detector detects maximum intensity 10 times, then finally a minimum intensity (when displacement is complete). The wavelength of sound is:
(a) 10/9 cm (b) 1 cm (c) 1/2 cm (d) 5/9 cm

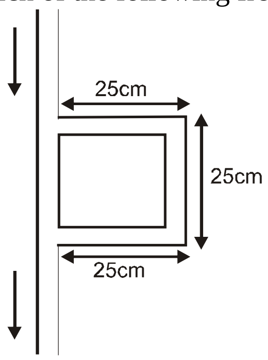
Q 2. A point source of power 50π watts is producing sound waves of frequency 1875Hz. The velocity of sound is 330m/s, atmospheric pressure is 1.0 x 10^5 Nm^2, density of air is 1.0 kgm^{-3}. Then pressure amplitude at r =$\sqrt{330}$ m from the point source is (using π = 22/7)
(a) 5 Nm^{-2}. (b) 10 Nm^{-2}. (c) 15 Nm^{-2} (d) 20 Nm^{-2}

Q 3. 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 4 I_0. If the velocity of sound is 330 m/s then the resultant intensity at P is



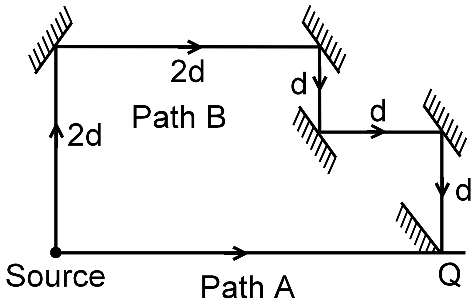
(a) I_0 (b) 9 I_0
(c) 3 I_0 (d) 8 I_0

Q 4. Given figure shows a sound filter in which sound is passing through a bifurcated pipe as shown. Speed of sound in air is 300 m/sec. A sound consists of four frequencies 300 Hz, 600 Hz, 900 Hz, 1500 Hz. Then which of the following frequency will pass through outlet:



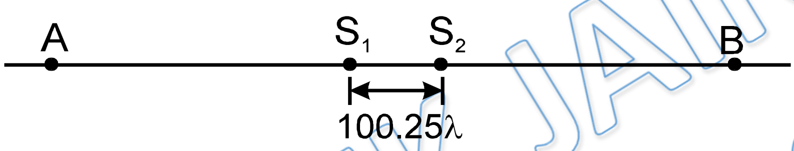
` (a) 300 Hz (b) 600 Hz (c) 900 Hz (d) 1500 Hz

Q 5. A sound source emits two sinusoidal sound waves, both of wavelength λ, along paths A and B as shown in figure. The sound travelling along path B is reflected from five surfaces as shown and then merges at point Q, producing minimum intensity at that point. The minimum value of d in terms of λ is:



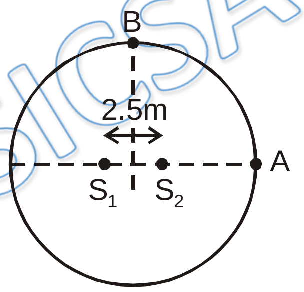
(a) $\frac{\lambda}{8}$ (b) $\frac{\lambda}{4}$ (c) $\frac{3\lambda}{8}$ (d) $\frac{\lambda}{2}$

Q 6. S_1 and S_2 are two coherent sources of radiations separated by distance 100.25 l, where l is the wave length of radiation. S_1 leads S_2 in phase by $\pi/2$. A and B are two points on the line joining S_1 and S_2 as shown in figure. The ratio of amplitudes of component waves from source S_1 and S_2 at A and B are in ratio 1:2. The ratio of intensity at A to that of B $\left(\frac{I_A}{I_B}\right)$is



(a) ∞ (b) $\frac{1}{9}$ (c) 0 (d) 9

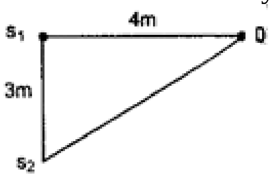
Q 7. Two radio frequency point sources S_1 and S_2 , separated by distance 2.5 m are emitting in phase waves of wavelength 1 m. A detector moves in a large circular path around the two sources in a plane containing them. The number of maxima that will be detected by it over the complete circular path, are



(a) 16 (b) 12 (c) 10 (d) 8

Q 8. The ratio of intensities between two coherent sound sources is 4: 1. The difference of loudness in decibels (dB) between maximum and minimum intensities, when they interfere in space is
(a) 10 log 2 (b) 20 log 3 (c) 10 log 3 (d) 20 log 2

Q 9. 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 4 m. Resultant intensity at D will be:



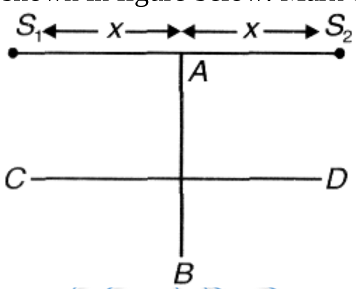
(a) $4I_0$ (b) I_0 (c) $2I_0$ (d) zero

Q 10. The intensity level at 10m away is 40 dB. What will be the intensity level 100 m away? Assume isotropic source.
(a) 4dB (b) 0.4dB (c) 30dB (d)20dB

Q 11. There are 10 sound sources each producing intensity l at point independently. They are incoherent, Average intensity of sound at that point will be
(a) I (b) 10 I (c)100 I (d) Zero

Q 12. A point source of sound is placed in a non-absorbing medium. Two points A and B are at distances of 1 m and 2 m, respectively from source. The ratio of amplitudes of wave at A and B is
(a) 1 : 1 (b)1 : 4 (c) 1 : 2 (d)2 : 1

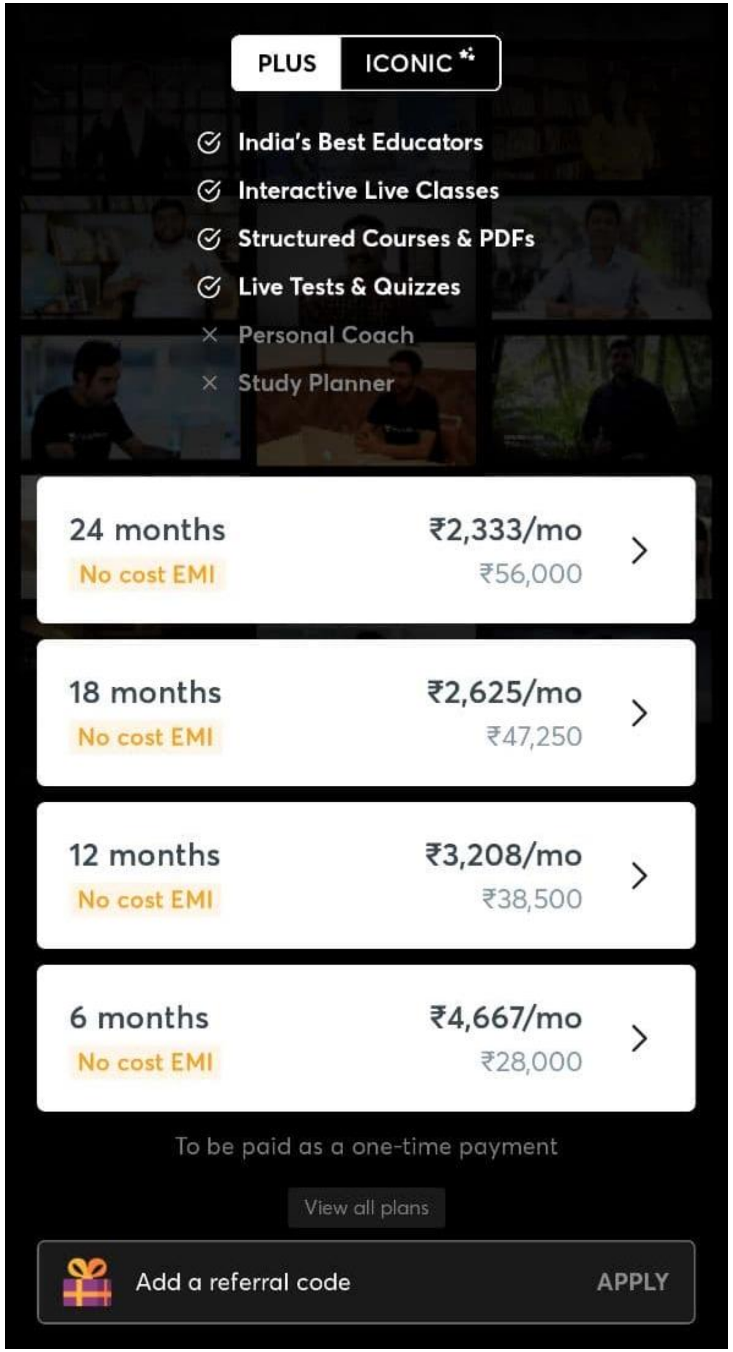
Q 13. Two speakers are placed as shown in figure below. Mark correct statements



(a)If person is moving along AB he will hear sound loud, faint loud and so on
(b)If person move on CD he will sound hear loud, faint, loud and so on
(c)If person move on AB he will with continuously decreasing intensity
(d)If person move on CD he will hear uniform intense sound

Answer Key

Q.1 b	Q.2 a	Q.3 c	Q.4 b	Q.5 a
Q.6 b	Q.7 c	Q.8 b	Q.9 c	Q.10 d
Q.11 b	Q.12 d	Q.13 b,c		



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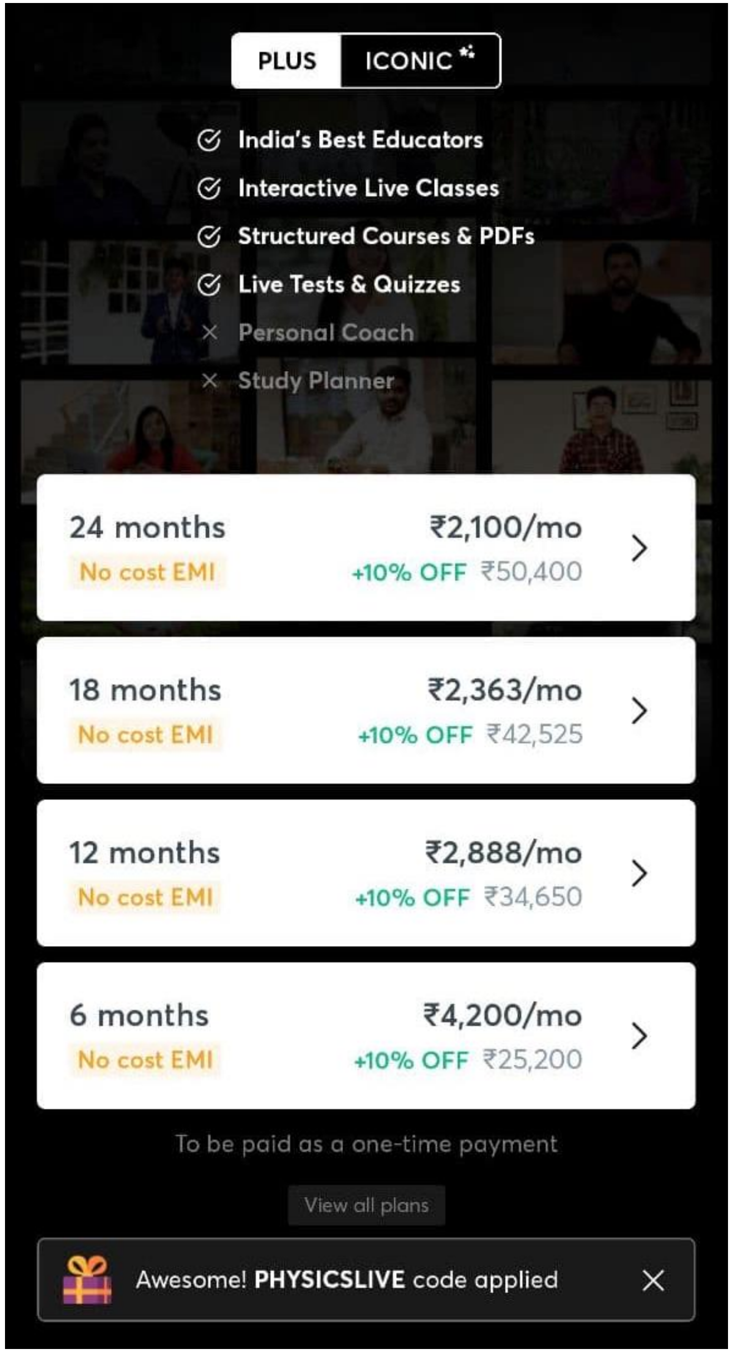

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Written Solution

DPP- 2 Sound : Intensity, Loudness & Quality of Sound and Interference of Sound waves, Quinkie's tube

By Physicsaholics Team

1)

Let initial minima heared was 1st minima.

$\Rightarrow$ final minima heared is 11th minima.

initial $\Delta x = \lambda/2 = .5\lambda$

final $\Delta x = 10.5\lambda$

Change in $\Delta x = 10.5\lambda - .5\lambda = 10\lambda$

Displacement of one tube $= 5cm$

$\Rightarrow$ change in $\Delta x = 2 \times 5cm = 10cm$

$10\lambda = 10cm$

$\lambda = 1cm$

Ans(b)

2) Power of point source = 50π watt

intensity at distance $\sqrt{330}$ m $= \dfrac{P}{4\pi r^2} = \dfrac{50\pi}{4\pi \times 330}$

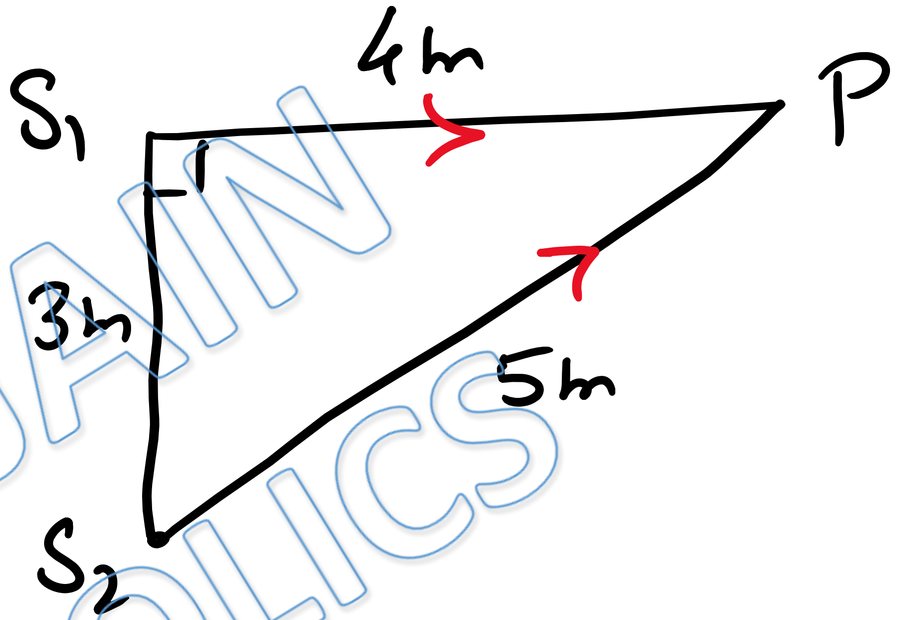
$$I = \frac{P_0^2}{2\rho v}$$

$$\Rightarrow P_0^2 = 2\rho v I = 2 \times 1 \times 330 \times \frac{5}{4 \times 33} = 25$$

$$\Rightarrow P_0 = 5\ N/m^2$$

Ans (a)

3) $V = 330\ m/sec$



$f = 110\ Hz$

$\Rightarrow \lambda = \frac{V}{f} = \frac{330}{110} = 3\ m$

$\Delta x = 5 - 4 = 1\ m$

$\phi = \frac{2\pi}{\lambda} \Delta x = \frac{2\pi}{3} \times 1$

$I = I_1 + I_2 + 2\sqrt{I_1 I_2} \cos\phi$

$= I_0 + 4I_0 + 2\sqrt{I_0 \times 4I_0} \cos 2\pi/3 = 3I_0$

Ans. c

4)

$V = 300\ m/sec$

$\Delta x = 75\ cm$

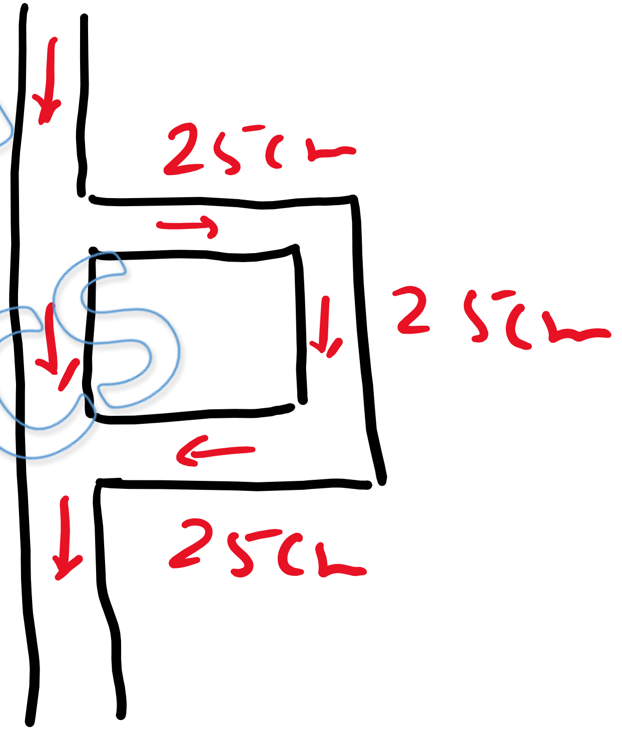
for maxima $\Delta x = 50\ cm$

$\lambda = \frac{50\ cm}{n} = \frac{.5}{n}\ m$

$\Rightarrow f = \frac{V}{\lambda} = \frac{300\ n}{.5}\ Hz$

$f = 600\ n\ Hz$

$= 600\ Hz,\ 1200\ Hz,\ 1800\ Hz.$



Ans (b)

5)

$$\Delta x = (2d + 2d + d + d + d) - (2d + d)$$

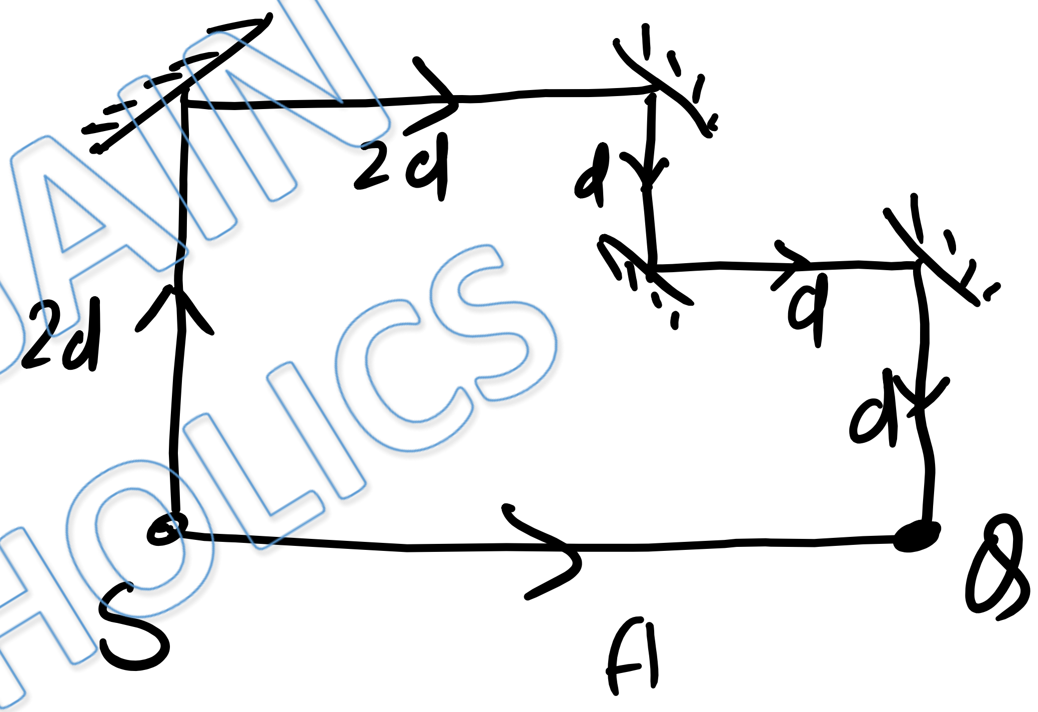
$$= 4d$$

for minima

$$\Delta x = (2n-1)\frac{\lambda}{2} = 4d$$

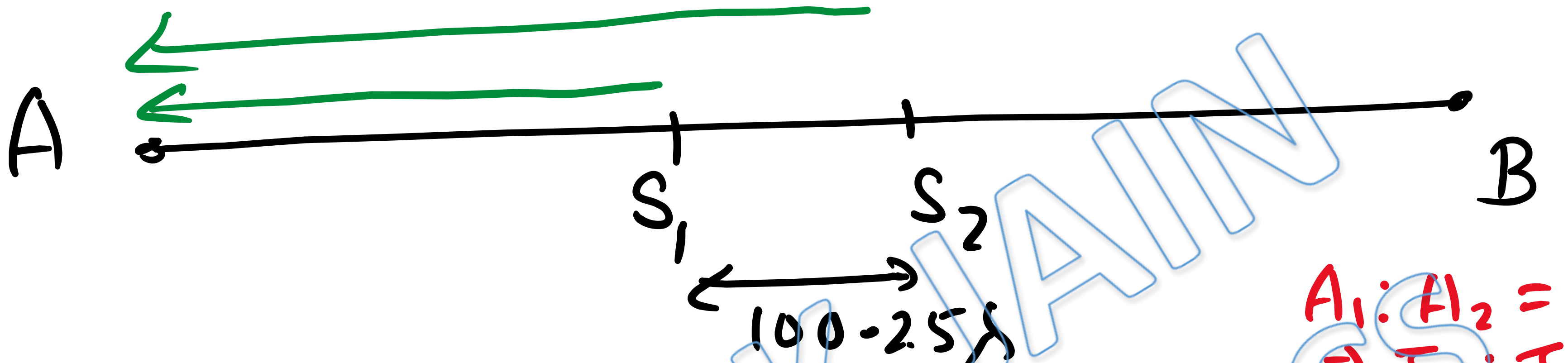
$$d = (2n-1)\lambda/8$$

$$d_{min} = \lambda/8 \quad \text{at} \quad n = 1$$



Ans (a)

6)



$A_1 : A_2 = 1 : 2$

$\Rightarrow I_1 : I_2 = 1 : 4$

Let intensity due to S_1 is I_0 and due to S_2 is $4I_0$

At A

$\Delta x = 100.25\lambda \Rightarrow \phi = \frac{2\pi}{\lambda}\Delta x = 200.5\pi$

due to path travelled S_1 is ahead in phase.

but S_1 was ahead in phase by $\pi/2$.

net phase difference $= 200.5\pi + .5\pi = 201\pi$

$\Rightarrow$ minima at A.

$$I_A = \left(\sqrt{4I_0} - \sqrt{I_0}\right)^2 = I_0$$

At B

$\Delta x = 100.25\lambda$

$\Rightarrow$ phase difference due to path travelled $= 200.5\pi$

At B S_2 is ahead in phase due to path travelled but S_1 was ahead in phase initially by $\pi/2$.

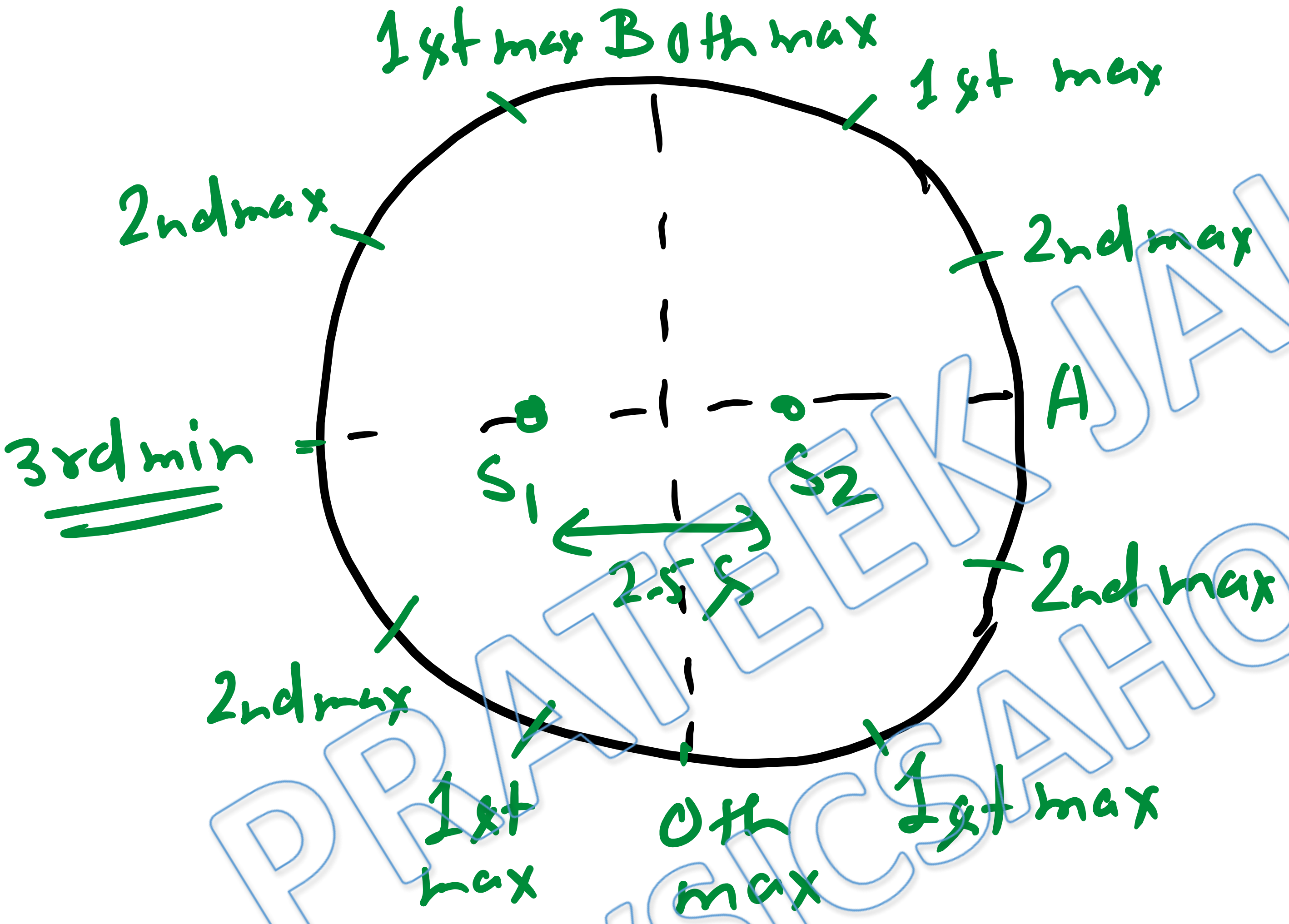
$\Rightarrow$ phase difference at B $= 200.5\pi - .5\pi$
$= 200\pi$

$\Rightarrow$ maxima at B.

$$I_B = \left(\sqrt{4I_0} + \sqrt{I_0}\right)^2 = 9I_0$$

Ans(b)

7)



At A

$\Delta x = 2.5\lambda$

$\Rightarrow$ 3rd minima.

At B

$\Delta x = 0$

$\Rightarrow$ 0th maxima.

Total 10 maxima on Circle.

Ans (c)

8) Difference in dB b/w max intensity & min intensity $= 10 \log \frac{I_{max}}{I_0} - 10 \log \frac{I_{min}}{I_0}$

$$= 10 \log \frac{I_{max}}{I_{min}}$$

$$= 10 \log \left(\frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}} \right)^2 = 10 \log \left(\frac{\sqrt{\frac{I_1}{I_2}} + 1}{\sqrt{\frac{I_1}{I_2}} - 1} \right)^2$$

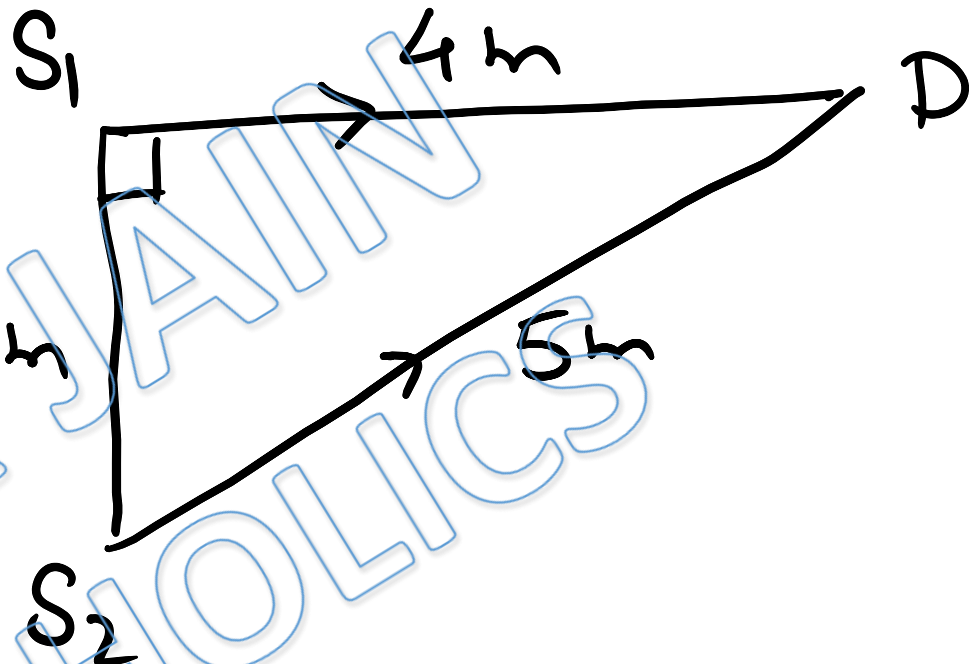
$$= 20 \log \frac{\sqrt{4} + 1}{\sqrt{4} - 1} = 20 \log 3$$

Ans (b)

9) <u>at D</u>

$\Delta x = 5 - 4 = 1m$

$\lambda = 4m$



$$\phi = \frac{2\pi}{\lambda}\Delta x$$

$$= \frac{2\pi}{4} \times 1 = \pi/2$$

$$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$$

$$= I_0 + I_0 + 2\sqrt{I_0 I_0}\cos\pi/2$$

$$= 2I_0$$

Ans (c)

10) Sound level $\beta = 10 \log \frac{I}{I_0}$

Sound level at r_1: $\beta = 10 \log\left(\frac{P}{4\pi r^2 I_0}\right)$

at r_2

$\beta_2 - \beta_1 = 10 \log\left(\frac{P}{4\pi I_0 r_2^2}\right) - 10 \log\left(\frac{P}{4\pi I_0 r_1^2}\right)$

$\beta_2 - 40 = 10 \log \frac{r_1^2}{r_2^2} = 20 \log \frac{r_1}{r_2}$

$\beta_2 - 40 = 20 \log \frac{10}{100} = -20$

$\beta_2 = 20 \, dB$

Ans (d)

11)

for incoherent sources

$$I_{net} = I_1 + I_2 + I_3 - - -$$

$$= 10I$$

Ans (b)

12)

for point source

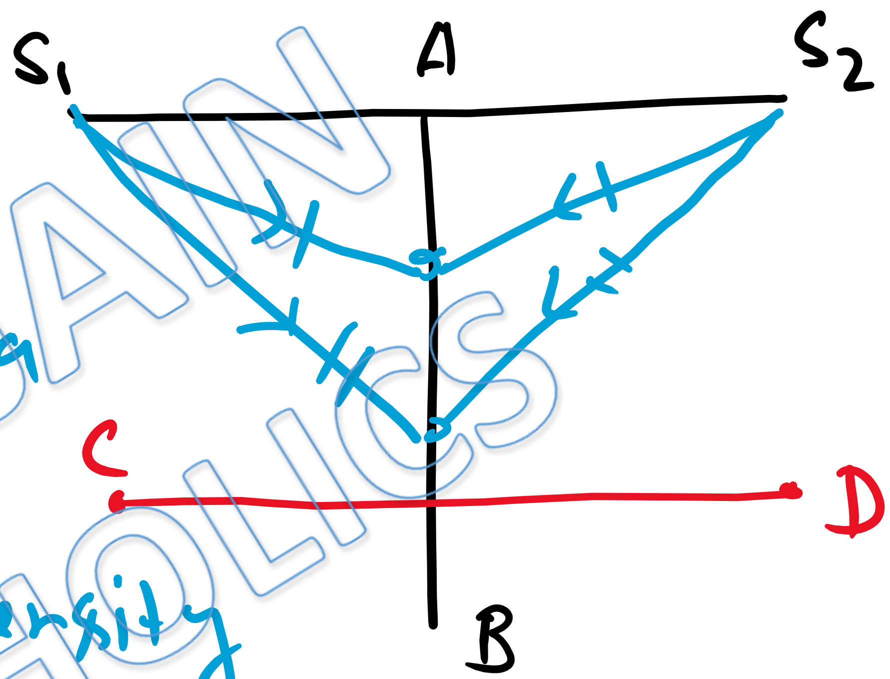
$I \propto \frac{1}{r^2}$ & $I \propto P_0^2$

$\Rightarrow P_0^2 \propto \frac{1}{r^2}$

$\Rightarrow P_0 \propto \frac{1}{r}$

Ans(d)

13)



for any point on AB

$\Delta x = 0 \Rightarrow$ Central maxima

$\Rightarrow$ no pattern.

On moving from A to B intensity decreases due to increment in distance from sources.

On moving from C to D, Δx will change with position $\Rightarrow$ maxima and minima will be there on CD.

Ans (b, c)

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