Physicsaholics

DPP – 2(Sound Waves)

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Q 1. The intensity of a sound wave gets reduced by 20% on passing through a slab. The reduction intensity on passage through two such consecutive slabs
(a) 40% (b) 36%
(c) 30% (d) 50%

Q 2. Two waves of equal frequencies have their amplitudes in the ratio of 3:5. They are superimposed on each other. Calculate the ratio of maximum and minimum intensities of the resultant wave.
(a) $\frac{16}{1}$ (b) $\frac{4}{1}$
(c) $\frac{9}{16}$ (d) $\frac{25}{16}$

Q 3. If the ratio of intensities of two sound waves is 1 : 25, then the ratio of their amplitudes will be
(a) 1 : 25 (b) 5 : 1
(c) 25 : 24 (d) 1 : 5

Q 4. When two sound waves with a phase difference of π/2, and each having amplitude A and frequency ω, are superimposed on each other, then the maximum amplitude and frequency of resultant wave is
(a) $\frac{A}{\sqrt{2}}, \frac{\omega}{2}$ (b) $\frac{A}{\sqrt{2}}, \omega$
(c) $\sqrt{2}A, \frac{\omega}{2}$ (d) $\sqrt{2}A, \omega$

Q 5. Two sound waves with amplitude 4cm and 3cm interfere with a phase difference of
(a) 0 (b) π/3 (c) π/2 (d) π
Find the resultant amplitude in each case.
(a) 5 cm, 6 cm, 7 cm, 1 cm
(b) 7 cm, $\sqrt{27}$ cm, 6 cm, 7 cm
(c) 5 cm, $\sqrt{39}$ cm, 1 cm, 5 cm
(d) 7 cm, $\sqrt{37}$ cm, 5 cm, 1 cm

Q 6. When a sound wave of frequency 30 Hz enters a medium, then maximum displacement of medium particles is 1 cm. The maximum velocity of the particles will be
(a) 60π cm/s (b) 30π cm/s
(c) 30 cm/s (d) 60 cm/s

Q 7. Loudness of sound increases with:
(a) The increase in distance from the source of sound
(b) The decrease in frequency of vibrating body
(c) The increase in surface area of vibrating body
(d) The amplitude of vibrating body

Q 8. The minimum intensity of audibility of sound is 10^{-12} watt/m^2. If the intensity of sound is 10^{-9} watt/m^2, then calculate the intensity level of this sound in decibels
(a) 30 dB (b) 20 dB
(c) 10 dB (d) 50 dB

Q 9. A sound of intensity I is greater by 3.0103 dB from another sound of intensity 10 nW/cm^2. The absolute value of intensity of sound level I in W/m^2
(a) 2.5×10^{-3} (b) 2×10^{-4}
(c) 2×10^{-2} (d) 2.5×10^{-2}

Q 10. Two identical sounds S_1 and S_2 reach at a point P in phase. The resultant loudness at point P is n dB higher than the loudness of S_1. the value of n is
[Take $\log 2 = 0.3$]
(a) 2 (b) 4
(c) 9 (d) 6

Q 11. A point source emits sound waves with an average power output of 80.0 W (a) Find the intensity 3.00 m from the source. (b) find the distance at which the intensity of the sound is 1.00×10^{-8} W/m^2
(a) 0.707 W/m^2, 5.2 km
(b) 1.07 W/m^2, 25.2 km
(c) 0.707 W/m^2, 25.2 km
(d) 1.07 W/m^2, 5.2 km

Q 12. At a distance r = 100m from a isotropic point sources of sound 200 Hz the loudness level is L = 50dB. The standard intensity level, i.e., intensity level just audible to human ear is I_0 = 0.1 nW/m^2. Find the sonic power of the source
(a) 7 W (b) 5 W
(c) 15 W (d) 1.25 W

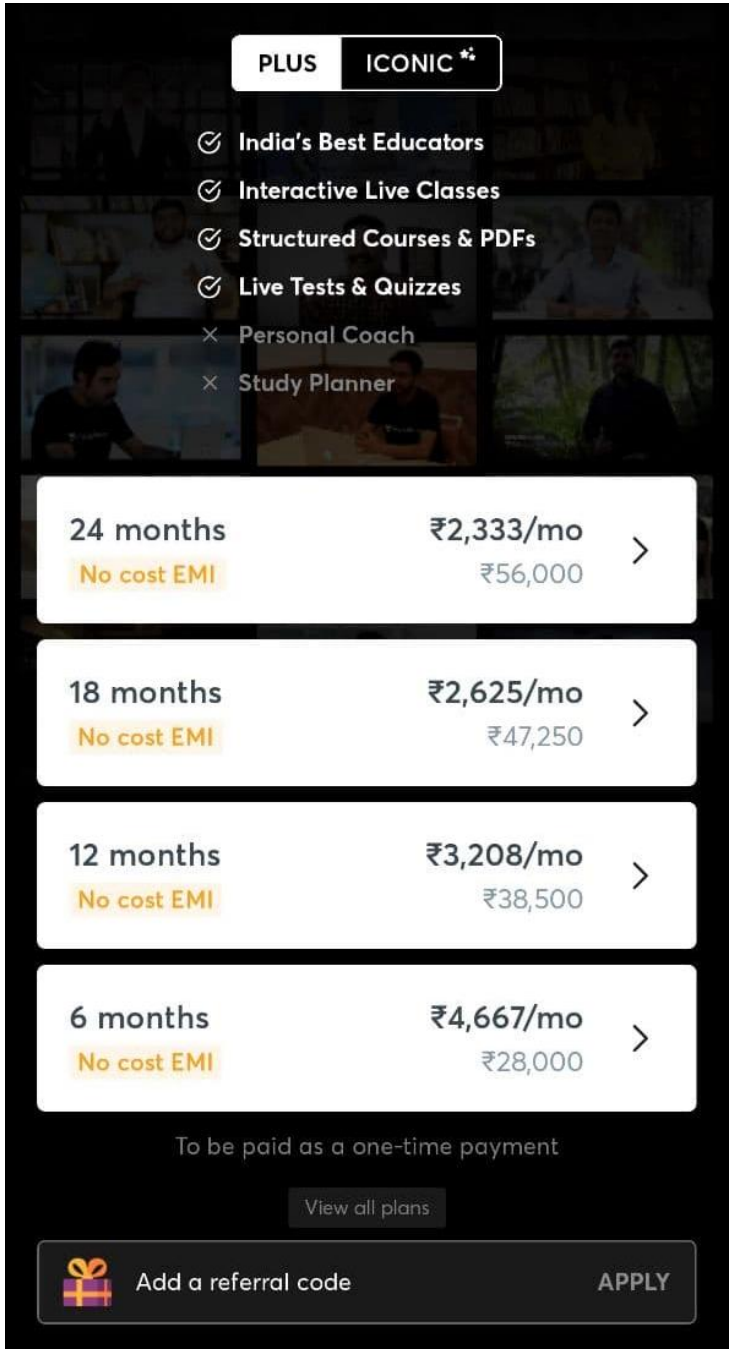
Q 13. The sound level at a point 5.0 m away from a point source is 40 dB. What will be the level at a point 50 m away from the source ?
(a) 10 dB (b) 20 dB
(c) 30 dB (d) 40 dB

Q 14. Quality of sound depends on
(a) Intensity (b) Loudness
(c) Wave form (d) Frequency

Q 15. The loudness and the pitch of a sound depends on
(a) intensity and velocity (b) frequency and velocity
(c) intensity and frequency (d) frequency and number of harmonics

Answer Key

Q.1 b	**Q.2 a**	**Q.3 d**	**Q.4 d**	**Q.5 d**
Q.6 a	**Q.7 d**	**Q.8 a**	**Q.9 b**	**Q.10 d**
Q.11 c	**Q.12 d**	**Q.13 b**	**Q.14 c**	**Q.15 c**



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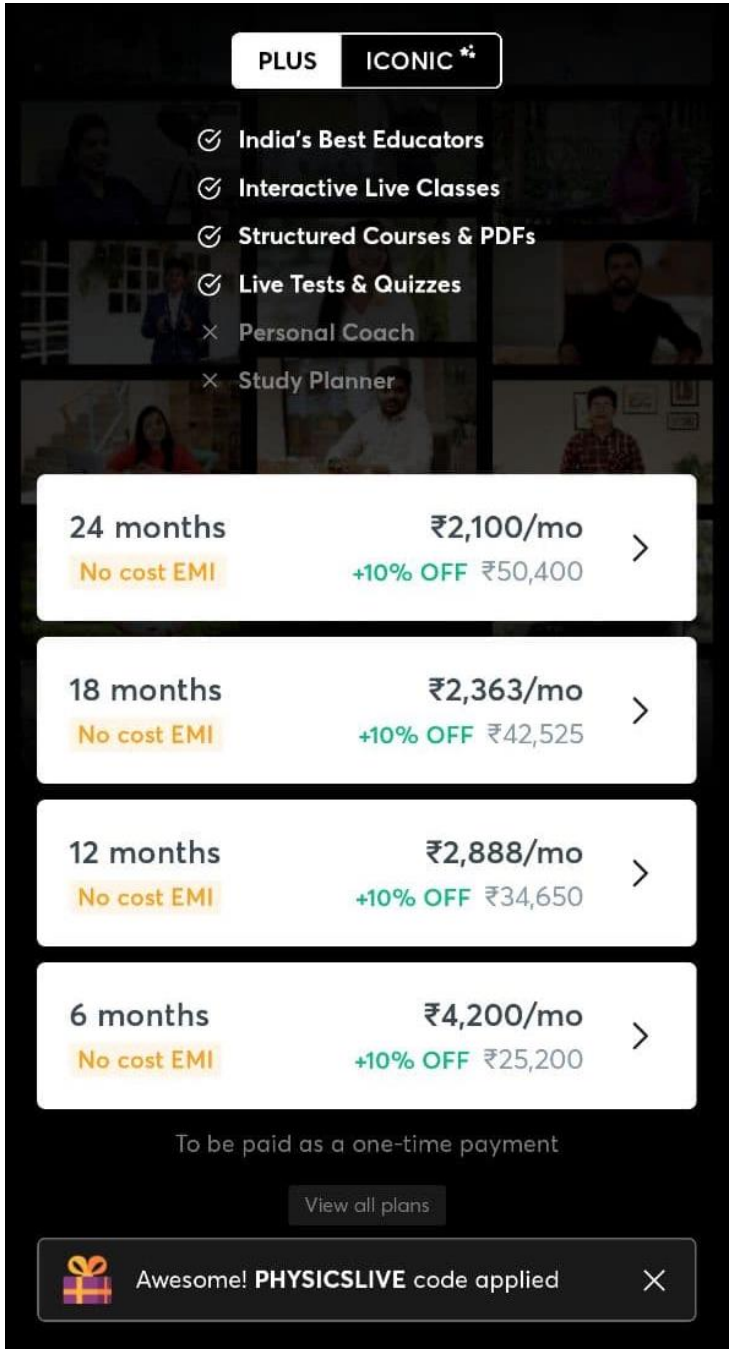

Written Solution

DPP-2 Sound Waves: Intensity, Loudness & Quality of Sound and Superposition of Sound waves

By Physicsaholics Team

Solution: 1

∵ 20% of Energy is reduced while passing through one slab. So; we can say that only 80% Intensity is passed.

So; $I_1 = 80\%$ of I_0

$\Rightarrow I_1 = \frac{80}{100} I_0 = \frac{4}{5} I_0$

$$\boxed{I_1 = \frac{4}{5} I_0}$$

And $I_2 = 80\%$ of I_1

$$I_2 = \frac{80}{100} \times \left(\frac{4}{5} I_0\right)$$

$$I_2 = \frac{4}{5}\left(\frac{4}{5} I_0\right)$$

$$\boxed{I_2 = \frac{16}{25} I_0}$$

So; reduced intensity

$$\Delta I = I_0 - I_2$$

$$\Delta I = I_0 - \frac{16}{25} I_0 = \frac{9}{25} I_0$$

$$\frac{\Delta I}{I_0} = \frac{9}{25}$$

$$\frac{\Delta I}{I_0} \times 100 = \frac{9}{25} \times 100$$

$$\boxed{\frac{\Delta I}{I_0}\% = 36\%}$$ Ans.

Ans. b

Solution: 2

$$\frac{A_1}{A_2} = \frac{3}{5}$$

$$\frac{I_{max}}{I_{min}} = \left(\frac{A_1 + A_2}{A_1 - A_2}\right)^2$$

$$= \left(\frac{\frac{A_1}{A_2} + 1}{\frac{A_1}{A_2} - 1}\right)^2$$

$$= \left(\frac{\frac{3}{5} + 1}{\frac{3}{5} - 1}\right)^2$$

$$= \left(\frac{8}{2}\right)^2$$

$$\boxed{\frac{I_{max}}{I_{min}} = \frac{16}{1}} \quad \text{Ans}$$

Ans. a

Solution: 3

$$\frac{I_1}{I_2} = \frac{1}{25}$$

$\because I \propto A^2$

$$\Rightarrow \frac{I_1}{I_2} = \frac{A_1^2}{A_2^2} = \left(\frac{A_1}{A_2}\right)^2$$

So, $\left(\frac{A_1}{A_2}\right)^2 = \frac{1}{25}$

$$\boxed{\frac{A_1}{A_2} = \frac{1}{5}}$$ Ans.

Ans. d

Solution: 4

$A_1 = A, \quad A_2 = A$

$\phi = \frac{\pi}{2}$

$A_R = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$

$= \sqrt{A^2 + A^2 + 2A^2\cos\frac{\pi}{2}}$

$= \sqrt{2A^2 + 2A^2 \cdot 0}$

$= \sqrt{2A^2}$

$\boxed{A_R = \sqrt{2}\,A}$ Ans

Ans. d

Solution: 5

$A_1 = 4\ cm, \quad A_2 = 3\ cm$

(a) $\phi = 0$

$$A = \sqrt{4^2 + 3^2 + 2(3)(4)\cos 0^\circ}$$

$$= \sqrt{16 + 9 + 24(1)}$$

$$= \sqrt{25 + 24}$$

$$= \sqrt{49}$$

$$\boxed{A = 7\ cm}$$

(b) $\phi = \pi/3$

$$A = \sqrt{(4)^2 + (3)^2 + 2(3)(4)\cos\frac{\pi}{3}}$$

$$= \sqrt{25 + \left(24 \times \frac{1}{2}\right)}$$

$$\boxed{A = \sqrt{37}\ cm}$$

(c) $\phi = \pi/2$

$$A = \sqrt{4^2 + 3^2 + 2(3)(4)\cos\pi/2}$$

$$= \sqrt{25 + (24 \times 0)} = \sqrt{25}$$

$$\boxed{A = 5\ cm}$$

(d) $\phi = \pi$

$$A = \sqrt{4^2 + 3^2 + 2(3)(4)\cos\pi}$$

$$= \sqrt{25 - 24} = \sqrt{1}$$

$$\boxed{A = 1\ cm}$$

Ans. d

Solution: 6

$A = 1\ cm$

$f = 30\ Hz$

$\omega = 2\pi f = 60\pi\ rad/s$

So, $(V_p)_{max} = A\omega$

$= (1\ cm) * (60\pi)$

$\boxed{V_{max} = 60\pi\ cm/s}$ Ans

Ans. a

Solution: 7

Loudness;

$$\beta = 10 \log_{10}\left(\frac{I}{I_0}\right)$$

$\because$ β only depends on I

$I \propto A^2$

so, β depends on amplitude.

Ans. d

Solution: 8

$I_0 = 10^{-12}\ w/m^2$

$I = 10^{-9}\ w/m^2$

$\beta = 10 \log_{10}\left(\frac{I}{I_0}\right)$

$\beta = 10 \log_{10}\left(\frac{10^{-9}}{10^{-12}}\right)$

$= 10 \log_{10}(10^3)$

$= 30 \log_{10} 10$

$\beta = 30\ dB$ Ans

Ans. a

Solution: 9

for $I_1 = 10\ nW/cm$

$= 10 \times 10^{-9}\ W/10^{-4}\ m^2$

$= 10^{-4}\ W/m^2$

$\beta_1 = 10 \log_{10}\left(\frac{I_1}{I_0}\right)$

$\because I_0 = 10^{-12}\ W/m^2$

$\beta_1 = 10 \log_{10}\left(\frac{10^{-4}}{10^{-12}}\right)$

$\boxed{\beta_1 = 80\ dB}$

$\because \beta = \beta_1 + 3.0103$

so, $\beta = 83.0103$

so, $\beta = 10 \log_{10}\left(\frac{I}{I_0}\right)$

$83.0103 = 10 \log_{10}\left(\frac{I}{10^{-12}}\right)$

$8.30103 = \log_{10}\left(\frac{I}{10^{-12}}\right)$

$\frac{I}{10^{-12}} = 10^{8.30103}$

$I = 10^{8.30103} \times 10^{-12}$

$I = 10^{0.30103} \times 10^{8} \times 10^{-12}$

$\boxed{I \simeq 2 \times 10^{-4}\ W/m^2}$ Ans

Ans. b

Solution: 10

if Intensity of sources S_1 & S_2 $= I_s$

then; Loudness due to single source

$$\beta_1 = 10 \log_{10}\left(\frac{I_s}{I_0}\right)$$

But when they interfere in same phase

$\Rightarrow \Delta\phi = 0$

& $I = 4I_s$

& $\beta = 10 \log_{10}\left(\frac{4I_s}{I_0}\right)$

so; $\Delta\beta = \beta - \beta_1 = 10\left[\log_{10}\left(\frac{4I_s}{I_0}\right) - \log_{10}\left(\frac{I_s}{I_0}\right)\right]$

$= 10 \times \log_{10}\left[\left(\frac{4I_s}{I_0}\right)\Big/\left(\frac{I_s}{I_0}\right)\right] = 10 \log_{10}(4)$

$\Delta\beta = 10 \times \log_{10} 2^2$

$\Delta\beta = 20 \log_{10} 2$

$\Delta\beta = 20 \times 0.3$

$\boxed{\Delta\beta = 6 \text{ dB}}$

so; $\boxed{n = 6}$ Ans.

Ans. d

Solution: 11

$P = 80\ W$

(a)

$$I = \frac{P}{A}$$

$$I = \frac{80}{4\pi r^2}$$

$$= \frac{80}{4\pi (3)^2}$$

$$= \frac{80}{4\pi \times 9}$$

$$I = 0.707\ W/m^2 \quad \text{Ans.}$$

(b)

$$I = \frac{P}{A}$$

$$1 \times 10^{-8} = \frac{80}{4\pi r^2}$$

$$r^2 = \frac{80}{4\pi \times 10^{-8}} = \frac{80 \times 10^8}{4\pi}$$

$$r^2 = 6.36 \times 10^8$$

$$r = 2.52 \times 10^4\ m$$

$$r \simeq 25.2\ km \quad \text{Ans.}$$

Ans. c

Solution: 12

$f = 200\ Hz$

$\Rightarrow$ at $r = 100\ m$; $L = 50\ dB$

& $I_0 = 0.1\ n\ w/m^2$

$I_0 = 10^{-10}\ w/m^2$

So; $\beta = 10 \log_{10}\left(\frac{I}{I_0}\right)$

$50 = 10 \log_{10}\left(\frac{I}{10^{-10}}\right)$

$5 = \log_{10}\left(\frac{I}{10^{-10}}\right)$

$\frac{I}{10^{-10}} = 10^5$

$I = 10^{-5}\ w/m^2$

& $I = \frac{P}{A}$

at $r = 100\ m = 10^2\ m$

$A = 4\pi r^2 = 4\pi (10^2)^2$

$P = I A$

$P = 10^{-5} \times 4\pi \times 10^4$

$P = 4\pi \times 10^{-1}$

$P = 1.25\ \Omega$

Ans. d

Solution: 13

at; $r_1 = 5\,m$

$\beta_1 = 40\,dB$

so; at $r_2 = 50\,m$

$\beta_2 = ?$

$\because I = \frac{P}{A} = \frac{P}{4\pi r^2}$

$\therefore \beta = 10 \log\left(\frac{I}{I_0}\right)$

$\log_{10}\left(\frac{I}{I_0}\right) = \beta/10$

$I = I_0 \cdot (10)^{\beta/10}$

$I = I_0 (10)^{\beta/10}$

$\frac{I_1}{I_2} = \frac{P/4\pi r_1^2}{P/4\pi r_2^2} = \left(\frac{r_2}{r_1}\right)^2$

so; $\frac{I_1}{I_2} = \left(\frac{r_2}{r_1}\right)^2 = \frac{I_0 (10)^{\beta_1/10}}{I_0 (10)^{\beta_2/10}}$

$\left(\frac{50}{5}\right)^2 = 10^{\left(\frac{\beta_1}{10} - \frac{\beta_2}{10}\right)} = 10^{\left(\frac{\beta_1 - \beta_2}{10}\right)}$

$10^2 = 10^{\left(\frac{\beta_1 - \beta_2}{10}\right)}$

so; $2 = \frac{\beta_1 - \beta_2}{10}$

$\beta_1 - \beta_2 = 20$

$\beta_2 = \beta_1 - 20 = 40 - 20$

$\boxed{\beta_2 = 20\,dB}$ Ans.

Ans. b

Solution: 14

Quality of sound depends on wave form.

Ans. c

Solution: 15

Loudness depends upon the amplitude of sound wave. Thus it depends upon its intensity. The larger the amplitude the more energy the sound wave contains therefore the louder the sound.

Pitch is a term used to describe how high or low a note being played by a musical instrument or sung seems to be. It is dependent upon the frequency of source of sound.

Ans. c

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