Acoustics

Day 1: Pressure Amplitude

1. If pressure amplitude of a sound wave is tripled, the intensity of sound increases to
   a. 3 times b. 6 times c. 9 times d. $\sqrt{3}$ times
2. If pressure of a sound wave is doubled, the intensity of sound
   a. increases 2 times b. decreases 2 times c. increases 4 times d. increases 8 times

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1. a. How does pressure amplitude change with displacement amplitude? Show that pressure wave varies with displacement wave by phase of 90^o.
   b. If the intensity of the song at your position is $1.4\ x\ 10^{-8}\ Wm^{-2}$ and frequency is $6kHz$, what are the pressure and displacement amplitudes? [velocity of sound= $320ms^{-1}$; density of air= $2.29Kgm^{-3}$.]
   [$\boldsymbol{Ans: 3.39\ x\ 10^{-3}Pa, 2.18\ x\ 10^{-10}\ m}$]
2. a. What is pressure amplitude? Describe sound wave as a pressure wave and deduce an expression for the pressure amplitude.
   b. Interpret sound wave graphically using comparison graph between displacement & pressure variation equation.
   c. Compare pressure amplitude & displacement amplitude for interpretation of sound wave.
   d. Water at 20°C has a bulk modulus of 2.2×10^9 Pa and the speed of sound in water at this temperature is 1480 m/s. For 1000 Hz, sound waves in water at 20°C, what displacement amplitude is produced if the pressure amplitude is $3\times10^{-2}\ Pa$. [**Ans: 3.2×10^{-32} m**]

Day 2: Intensity and Intensity level

3. a. Define the intensity of sound. Mention its unit & dimension.
   b. Show that the intensity of sound for a given frequency is directly proportional to the square of amplitude of vibration.
   c. Why does an empty vessel produce more sound than a filled one?
   d. The ratio of intensities of two waves at a point is 25: 16. Calculate the ratio of amplitude of two waves.
   e. Does amplitude of sound decrease with distance from the source? Explain.
   f. What is the minimum value of sound intensity that normal ear can hear clearly.
   g. Differentiate between (i) music and noise (ii) infrasonic, sonic and ultrasonic sound.
   h. Find the amplitude of vibration of the particles of air through which a sound wave of intensity $2\times10^{-6}W/m^2$ and frequency 1 KHz is passing. Density of air is 1.2 kg/m^3 and speed of sound in air is 330 m/s. [$\boldsymbol{1.6\times10^{-8}\ m}$]
4. a. What do you mean by intensity and intensity level of sound? Is there any relation between them?
   b. Define bel and decibel? Write their relation. Write short notes on (i)pitch (ii) loudness and (iii) quality of sound.
   c. When a jet plane is flying on elevation of $1000m$ the sound level on the ground is 4.0 dB. What would be the intensity level on the ground when its elevation is as low as 100m? [**Ans: 24 dB**]
   d. A sound has an intensity of $5\times10^{-7}\ Wm^{-2}$. What is decibel sound level? What is the bel level? [$\boldsymbol{57\ dB;\ 5.7\ bel}$]

Task for weekend:

1. The reference intensity of audibility is $10^{-12}\ W\ m^{-2}$. The sound level for intensity $10^{-4}\ W\ m^{-2}$ will be:
   a. 8 dB b. 80 dB c. 108 dB d. 160 dB
2. The intensity levels of two waves of same frequency in a given medium are 20 dB *and* 60 dB. Then the ratio of their amplitude is
   a. 1: 4 b. 1: 16 c. 1: 100 d. 1: 104
3. The maximum tolerable sound intensity in dB is
   a. 0 dB b. 1 dB c. 120 dB d. 200 dB
4. The intensity levels of two waves of same frequency in a given medium are 20 dB *and* 60 dB. Then the ratio of their amplitude is
   a. 1: 4 b. 1: 16 c. 1: 100 d. 1: 104
5. A beam of sound is 10^6 times as intense as that with minimum audible intensity. The intensity level of the beam is
   a. 10^6 dB b. 60 dB c. 6 dB d. 0.6 dB

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1. Intensity of sound from a point source is $10^{-8}\ Wm^{-2}$at a distance of 5 m. What will be the intensity and intensity level of sound at a distance of 20 m from the same source. [$\boldsymbol{6.25\times10^{-10}Wm^{-2};\ 27.95\ dB}$]
2. The power output of a point source of sound is 1 Watt. It radiates sound energy uniformly in all directions. Calculate the intensity level at distances (i) 100 m and (ii) 500 m from the source. [$\boldsymbol{69\ dB\ ;\ 55\ dB}$]
3. When a jet plane is flying at an elevation of 1000m, the sound level on the ground is 4 dB. What would be the intensity level on the ground when its elevation is as low as 50 m? [$\boldsymbol{30\ dB}$]
4. The volume level of an outdoor public address system is adjusted to 55 dB for people 5 m away. What will be its intensity level for people at distance 45 m? [$\boldsymbol{35.9\ dB}$]
5. If the intensity of sound is doubled, by how many decibels does the sound level increase? [$\boldsymbol{3\ dB}$]