Q- A loudspeaker emits a power of 100 W and can be considered as appoint source. Find the sound intensity and sound level in dB at a distance of 10 m from the speaker. How close would you have to be to the speaker for the sound level to be at the threshold of pain (120 dB)? (The threshold of hearing is $1*10^{-12}$ Wm^{-2}.)

The intensity of the sound at a point is the amount of energy received at that point per unit time per unit area normal to the wave motion. At distance r from the point source of sound of power P, the intensity is given by

$$I = P/(4\pi r^2)$$

Hence the intensity at a distance of 10 m from the speaker is given by

$$I = 100/(4*3.1415*100) = 0.0796 = \mathbf{7.96*10^{-2}\ W/m^2}$$

The level of sound is the measure of the effect of the sound wave on human ears. It is proportional to the logarithm of the intensity of sound and is given in dB as

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

Where I is the intensity of the sound and I_o is the threshold of hearing.

Hence the level of sound is given by

$$L = 10\ log\left(\frac{7.96 * 10^{-2}}{1 * 10^{-12}}\right) = 10\ log\left(7.96 * 10^{10}\right)$$

Or L = 109.01 dB

Now for the level to be the threshold of pain (120 dB) the intensity I should be given by

$$120 = 10\ log\left(\frac{I}{1*10^{-12}}\right)$$

or $$10^{12} = \left(\frac{I}{1*10^{-12}}\right)$$

or $I = 1.0\ W/m^2$

and the distance r for this is given by

$$P/(4\pi r^2) = 1$$

Or $$r = \sqrt{\frac{P}{4\pi}} = \sqrt{\frac{100}{4*3.14}} = 2.82\ m$$