5) a) Case 1. Sound intensity increases from $I_{11} = 1\times10^{-7}\frac{W}{m^2}$ to $I_{12} = 2\times10^{-7}\frac{W}{m^2}$

Location 1, Intensity setting 1

$$\Delta L_1 = L_{12} - L_{11}$$

$$= 10\,dB \log \frac{I_{12}}{I_0} - 10\,dB \log \frac{I_{11}}{I_0}$$

$$= 10\,dB \left(\log \frac{I_{12}}{I_0} - \log \frac{I_{11}}{I_0} \right)$$

$$= 10\,dB \log \frac{I_{12}}{I_0}\frac{I_0}{I_{11}}$$

$$* \quad \Delta L_1 = 10\,dB \log \frac{I_{12}}{I_{11}} = 10\,dB \log \frac{2\times10^{-7}\frac{W}{m^2}}{1\times10^{-7}\frac{W}{m^2}}$$

$$\boxed{\Delta L_1 = 3.0103\,dB}$$

b) Case 2 Sound intensity increases from $I_{21} = 1.00\times10^{-6}\frac{W}{m^2}$ to $I_{22} = 1.10\times10^{-6}\frac{W}{m^2}$.

using "*" w/ $I_{12} \rightarrow I_{22}$ & $I_{11} \rightarrow I_{21}$ $\Rightarrow$

$$\Delta L_2 = 10\,dB \log \frac{I_{22}}{I_{21}} = 10\,dB \log \frac{1.10\times10^{-6}\frac{W}{m^2}}{1.00\times10^{-6}\frac{W}{m^2}}$$

$$\boxed{\Delta L_2 = .4139\,dB}$$

c) In each case the new intensity is some factor times the old intensity. The loudness increase is 10dB times the log of the factor. In the first case the factor is 2. In the second case, despite the fact that the amount of increase is the same, because the starting intensity is greater than the starting intensity in the first case, that increase is a smaller percentage of the starting intensity, meaning the factor is smaller. A smaller factor means a smaller log of the factor, and hence a smaller increase in level.

The factor in the second case is 1.1