國立東華大學

Department of Physics
National Dong Hwa University, 1, Sec. 2,
Da Hsueh Rd., Shou-Feng, Hualien, 97401, Taiwan

General Physics-I, Quiz 5
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Chapter17-18, Serway; ABSOLUTELY NO CHEATING!
Please write down the answers on the blank space or on the back of this paper. Answer should be in english. [ ] indicates the question points.

Q1. Suppose a firework charge is detonated at the top of Taipei-101 as show in figure. Due to the explosion if the acoustic pressure is reached maximum of $\Delta P_{max} = 20$ Pa at the distance of 1st person $d_1 = 1\text{x}10^3$ m from the explosion, what sound level will be experienced by the 2nd person at a distance of $d_2 = 4 \text{ x } 10^3$ m? Let the speed of sound is constant at 332 m/s throughout the atmosphere and the air absorbs sound energy at the rate of 10 dB/km, the density of air ρ=1.2 kg/m^3 and $I_0 = 10^{-12}$ w/m^2 [50] **Similar to p.33 chapter 17**

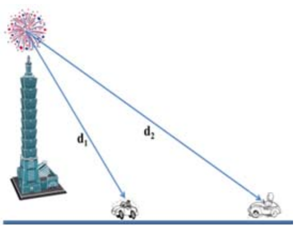
Solutions: The sound intensity at distance d_1 is, suppressing units,

$$I_1 \frac{\Delta P_{max}^2}{2\rho\upsilon} = \frac{(20)^2}{2(1.20)(332)} = 0.5\,\mathrm{W/m^2}$$

If air does not absorb sound energy, the intensity of sound is inversely proportional to the square of the distance from its source. The intensity at distance d_2 is

$$I_2 = \left(\frac{d_1}{d_2}\right)^2 I_1 = \left(\frac{1000\,\mathrm{m}}{4000\,\mathrm{m}}\right)^2 I_1 = \frac{1}{16}\left(0.5\,\mathrm{W/m^2}\right)$$
$$= 3.1\times10^{-2}\,\mathrm{W/m^2}$$

which has an intensity level of



$$\beta_2 = (10\ \mathrm{dB})\log\left(\frac{I_2}{I_0}\right) = (10\ \mathrm{dB})\log\left(\frac{3.1\times10^{-2}\ \mathrm{W/m^2}}{10^{-12}\ \mathrm{W/m^2}}\right)$$
$$= 100.4\ \mathrm{dB}$$

Allowing for absorption of the wave over the distance traveled,

$$\beta_2' = \beta_2 - (10\,\mathrm{dB/km})(4000m - 1000\mathrm{m}) = 74.0dB$$

Q2. Guzheng (古箏) is a popular Chinese traditional musical instrument. During playing Guzheng if you create two waves on one string which are expressed by the wave functions $\mathbf{Y_1 = 4\cos(4x - 1.5t + \phi)}$ and $\mathbf{Y_2 = 5\sin(4x - 2t + \phi)}$, what will be their superposition ($\mathbf{Y_1 + Y_2}$) at the points (a) $x = 1$m, $t = 1$s, $\phi = 0$ and (b) $x = 0.5$m, $t = 0$s, $\phi = 0$. (c) What results are expected for (a) and (b) if you change the phase $\phi = 2\pi$, explain.
[20+20+10 = 50]   **Similar to p.3 chapter 18**

Solutions: The superposition of the waves is given by

$$Y = Y_1 + Y_2 = 4\cos(4x - 1.5t + \phi) + 5\sin(4x - 2t + \phi)$$

Evaluated at the given x values.

(a) At $x = 1.00$, $t = 1.00$, $\phi = 0$ the superposition of the two waves gives

$$y = 4\cos[4(1.0) - 1.5(1.0)]$$
$$+ 5\sin[4(1.0) - 2(1.0)]$$
$$= 4\cos(2.5 \text{ rad}) + 5\sin(2.0 \text{ rad}) = 1.34 \text{ m}$$

(b) At $x = 0.5$, $t = 0$, $\phi = 0$ the superposition of the two waves gives

$$y = 4\cos[4(0.5) - 1.50(0)]$$
$$+ 5\sin[4(0.5) - 2(0)]$$
$$= 4\cos(0.5 \text{ rad}) + 5\sin(0 \text{ rad}) = 3.15 \text{ m}$$

(c) If $\phi = 2\pi$, there will be no change of the result of (a) and (b) because

$\sin(2\pi + \theta) = \sin\theta$ and $\cos(2\pi + \theta) = \cos\theta$.