Reading 1/14 Solutions

① (a) Consider audible sound range and EM spectrum

$f: 20\,Hz - 20\,kHz$ ~~radio~~
$\lambda: 17\,m - 17\,mm$

(i) Basically impossible: under normal conditions

$V_{sound} = 343\ m/s$ (in air, room temp.)

$V_{light} = c = 3\times10^8\ m/s$ (in vacuum)

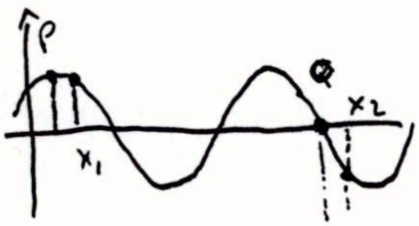
(ii) $\boxed{\text{This is most likely}}$ audible sound waves have $\lambda \sim 1m$ which is somewhere in between radio waves and microwaves

(iii) Possibly, but not very likely: audible sound waves have $f \sim 100\,Hz$, which is a very low frequency for EM waves (look up ULF in Wikipedia)

(b) $\lambda \sim 1\,m$ radio / microwaves

(2)

(a) Phase difference between x_1 and x_2 is about the same as between P (node) and Q (antinode)



$$\Delta\phi \simeq 2\pi + \frac{\pi}{2} = \frac{5\pi}{2}$$

(b) This graph is obtained by taking $\cos(kx)$ and shifting it a little to the <u>right</u> so $D = A\cos(kx - \pi/4)$ and ϕ_0 is <u>negative</u>

(3) (a) An absolute intensity that <u>doubles</u> corresponds to an increase in sound of <u>3 dB</u> so $\boxed{73\text{ dB}}$

$$\beta_f - \beta_i = (10\text{ dB})\left[\log_{10}\left(\frac{2I_i}{I_0}\right) - \log_{10}\left(\frac{I_i}{I_0}\right)\right]$$

$$= (10\text{ dB})\left[\log_{10}\left(\frac{2\cancel{I_i}}{\cancel{I_i}}\right)\right] \approx (10\text{ dB})(0.3)$$

$$\approx 3\text{ dB}$$

(b) To increase decibel level by 10 dB, need to increase absolute intensity by 10x. 70 dB → 100 dB means increasing by 10x <u>3 times</u> ⇒ $10^3 = 1000\times$ increase in intensity

$\boxed{\text{1000 guitar players}}$