

PHYS-1200 PHYSICS II
HOMEWORK #13 SOLUTIONS

15.) The problem says “At one instant..” and we choose that instant (without loss of generality) to be $t = 0$. Thus, the displacement of “air molecule A” at that instant is

$$s_A = +s_m = s_m \cos(kx_A - \omega t + \phi)|_{t=0} = s_m \cos(kx_A + \phi),$$

where $x_A = 2.00$ m. Regarding “air molecule B” we have

$$s_B = +\frac{1}{3}s_m = s_m \cos(kx_B - \omega t + \phi)|_{t=0} = s_m \cos(kx_B + \phi).$$

These statements lead to the following conditions:

$$\begin{aligned} kx_A + \phi &= 0 \\ kx_B + \phi &= \cos^{-1}(1/3) = 1.231 \end{aligned}$$

where $x_B = 2.07$ m. Subtracting these equations leads to

$$k(x_B - x_A) = 1.231 \Rightarrow k = 17.6 \text{ rad/m.}$$

Using the fact that $k = 2\pi/\lambda$ we find $\lambda = 0.357$ m, which means

$$f = v/\lambda = 343/0.357 = 960 \text{ Hz.}$$

Another way to complete this problem (once k is found) is to use $kv = \omega$ and then the fact that $\omega = 2\pi f$.

5. If f is the frequency and λ is the wavelength of an electromagnetic wave, then $f\lambda = c$. The frequency is the same as the frequency of oscillation of the current in the LC circuit of the generator. That is, $f = 1/2\pi\sqrt{LC}$, where C is the capacitance and L is the inductance. Thus

$$\frac{\lambda}{2\pi\sqrt{LC}} = c.$$

The solution for L is

$$L = \frac{\lambda^2}{4\pi^2 C c^2} = \frac{(550 \times 10^{-9} \text{ m})^2}{4\pi^2 (17 \times 10^{-12} \text{ F})(2.998 \times 10^8 \text{ m/s})^2} = 5.00 \times 10^{-21} \text{ H}.$$

This is exceedingly small.

6. The emitted wavelength is

$$\lambda = \frac{c}{f} = 2\pi c \sqrt{LC} = 2\pi (2.998 \times 10^8 \text{ m/s}) \sqrt{(0.253 \times 10^{-6} \text{ H})(25.0 \times 10^{-12} \text{ F})} = 4.74 \text{ m}.$$

8.) The amplitude of the magnetic field in the wave is

$$B_m = \frac{E_m}{c} = \frac{3.20 \times 10^{-4} \text{ V/m}}{2.998 \times 10^8 \text{ m/s}} = 1.07 \times 10^{-12} \text{ T}.$$

16.08) a.) 8; b.) antinode; c.) longer; d.) lower

16.11) *d*