

1. Express the wave function for one-dimensional harmonic waves in terms of the following parameters:

- Frequency and wavelength
- Period and wavelength
- Angular frequency and wave vector

$$1) \eta(x) = A \cos\left(\frac{2\pi x}{\lambda} - 2\pi v t + \phi\right)$$

$$2) \eta(x) = A \cos\left(\frac{2\pi x}{\lambda} - \frac{2\pi}{T} t + \phi\right)$$

3)

starting place  $\rightarrow$

$$\eta(x) = A \cos(k(x - vt) + \phi)$$

$$\text{or} \\ \eta(x) = A \cos(kx - \omega t + \phi)$$



2. Consider the plane electromagnetic wave in vacuum (in SI units) given by the expressions:

$$E_x = 0$$

$$E_y = 4 \cos[2\pi * 10^{14}(t - x/c) + p/2]$$

$$E_z = 0$$

$$\omega\left(t - \frac{x}{c}\right) = \omega t - \underbrace{\frac{\omega x}{c}}_k$$

not sure about

but  $k \cdot v = \omega$

$$\text{and } v = \underbrace{\frac{\omega}{k}}_{\lambda} = \lambda \cdot v$$

$$\text{so since } \omega = 2\pi \cdot 10^{14} \quad \omega = 2\pi v$$

$$\text{then } v = 10^{14} \text{ Hz}$$

$$\lambda = \underbrace{\frac{2\pi}{\omega}}_{c} = \frac{2\pi c}{\omega}$$

$$\text{but also } \lambda = \frac{v}{\omega}$$

$$\text{so } \lambda = \frac{c}{10^{14}} = \frac{3 \cdot 10^8}{10^{14}} = 3 \cdot 10^{-6} = 3 \mu\text{m}$$

3. Write an expression for the  $\vec{E}$  and  $\vec{B}$  fields that constitute a plane harmonic wave traveling in the  $+z$ -direction. The wave is linearly polarized with its plane of vibration at  $45^\circ$  to the  $yz$ -plane.
4. A 500-nm harmonic EM wave, whose electric field is in the  $z$ -direction, is traveling in the  $y$ -direction in vacuum.
- What is the frequency of the wave?
  - Determine both  $v$  and  $k$  for this wave.
  - If the electric field amplitude is 700 V/m, what is the amplitude of the magnetic field?
  - Write an expression for both  $E(t)$  and  $B(t)$  given that each is zero at  $x = 0$  and  $t = 0$ . Put in all the appropriate units.

5. Consider a linearly polarized plane electromagnetic wave traveling in the  $+x$ -direction in free space having as its plane of vibration the  $xy$ -plane. Given that its frequency is 5 MHz and its amplitude is  $E_0 = 0.05 \text{ V/m}$

- Find the period and wavelength of the wave.
- Write an expression for  $E(t)$  and  $B(t)$ .
- Find the flux density,  $\langle S \rangle$ , of the wave.

6. A light wave travels from point A to point B in vacuum. Suppose we introduce into its path a flat glass plate ( $n = 1.50$ ) of thickness  $L = 1.00 \text{ mm}$ . If the vacuum wavelength is 500 nm, how many waves span the space from A to B with and without the glass in place? What phase shift is introduced with the insertion of the plate?

