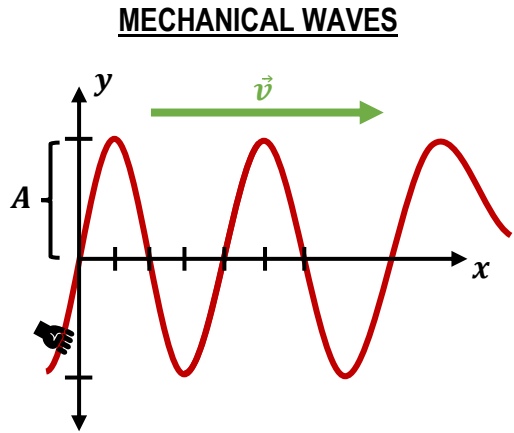


CONCEPT: WAVE FUNCTIONS FOR ELECTROMAGNETIC WAVES

- EM waves are just like other sinusoidal transverse waves, and sometimes you'll have to write their wave functions.

- Because E.M waves are ____ oscillating waves, you'll need to write ____ wave functions to describe them.

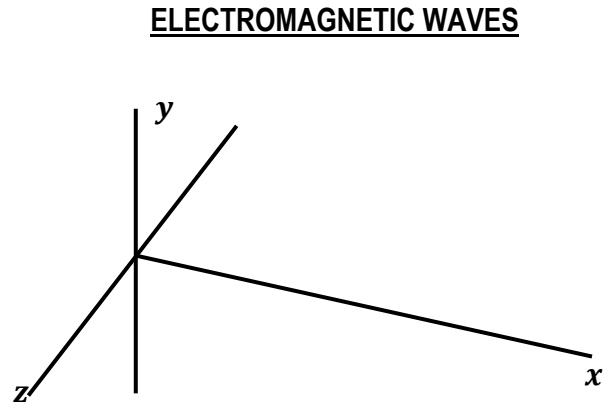


$$y(x, t) = A \sin(kx - \omega t)$$

Important Wave Variables/EQs

$$k = \frac{2\pi}{\lambda} \text{ (Wavenumber)}$$

$$\omega = 2\pi f = vk \text{ (Angular Freq.)}$$



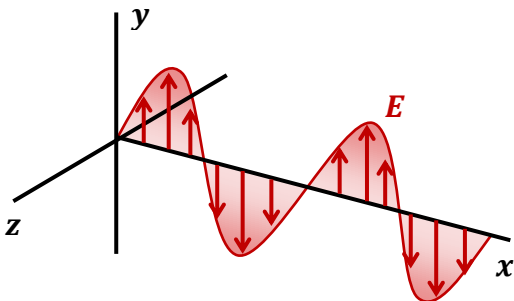
$$E_y(x, t) = \text{____} \sin(kx - \omega t)$$

$$B_z(x, t) = \text{____} \sin(kx - \omega t)$$

[Note: Your book/class may use *cos* instead of *sin*]

- Subscripts below E & B indicate which ____ the field is parallel to
- E & B are ALWAYS "in phase", i.e. they have the same ____
 - They reach min/0/max values ____

EXAMPLE: An infrared laser emits a $10\mu\text{m}$ wavelength light beam in the z -direction in a vacuum, as shown in the figure below. The E -field is parallel to the x -axis and has a max value of $1.5 \times 10^6 \text{ V/m}$, and the B -field is parallel to the y -axis. Write the wavefunctions of E and B .



- Problems *usually* tell you to use sin or cos, but if they don't show a wave's "start" point with graph/text, choose one!

PROBLEM: Electromagnetic waves produced by X-ray machines typically have a frequency of approximately 3.5×10^{16} Hz. What is the wave number of these waves?

E.M. WAVES EQUATIONS
$k = \frac{2\pi}{\lambda}$ $\omega = 2\pi f = ck$
CONSTANTS
$c = 3.0 \times 10^8 \text{ m/s}$

PROBLEM: The electric field of an electromagnetic wave is described by the equation $E_y = 54 \sin(2 \times 10^7 x - \omega t)$.

- Find the amplitude of the magnetic field.
- Calculate the frequency of this EM wave.

E.M. WAVES EQUATIONS
$E = E_{max} \sin(kx - \omega t)$ $B = B_{max} \sin(kx - \omega t)$ $E_{max} = cB_{max}$ $k = \frac{2\pi}{\lambda}$ $\omega = 2\pi f = ck$
CONSTANTS
$c = 3.0 \times 10^8 \frac{m}{s}$

PROBLEM: The magnetic field of a travelling electromagnetic wave is described by the wavefunction $B(z, t) = 1.0 \times 10^{-3} \sin(kz - 1.27 \times 10^{12}t)$, where k is the wavenumber. Write the *complete* wavefunction for the electric field of this wave.

E.M. WAVES EQUATIONS
$E = E_{max} \sin(kx - \omega t)$ $B = B_{max} \sin(kx - \omega t)$ $E_{max} = cB_{max}$ $k = \frac{2\pi}{\lambda}$ $\omega = 2\pi f = ck$
CONSTANTS
$c = 3.0 \times 10^8 \frac{m}{s}$