→ Introduction to Electromagnetic (EM) Radiation.

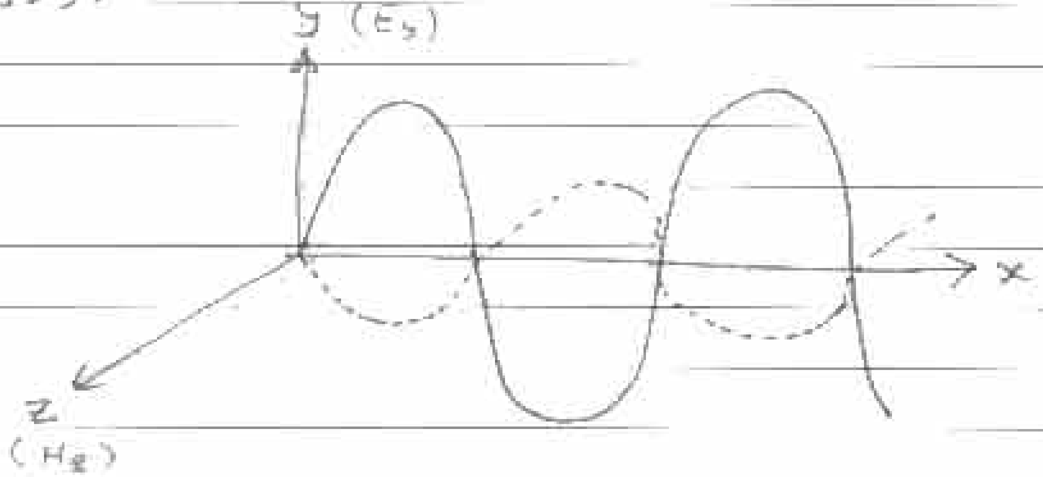
Spectroscopy is the science that studies the interaction between light (radiation) and matter (atoms and molecules).

Spectroscopy is basically an experimental subject that concerns with: absorption, emission, or scattering of EM radiation by atoms or molecules.

Spectrometry is the science that uses spectroscopic techniques to assess the concentrations (or amounts) of a given sample.

→ Nature of Electromagnetic (EM) Radiation.

Visible and invisible radiation can be regarded as waves with electric (E) and magnetic (H) components (First proposed by Maxwell in 1855).



EM is of a dual character:

(1) Electric component: It has the form of an oscillating electric field ($\vec{E}$). The electric field magnitude and direction is specified by the vector $\vec{E}$.

(2) Magnetic component: It has the form of an oscillating magnetic field ($\vec{H}$). The magnetic field magnitude and direction is specified by the vector $\vec{H}$.

$\vec{E}$ and $\vec{H}$ vectors oscillate perpendicular to each other and are in phase as well.
They can be mathematically represented as:

$$\vec{E}_y = E_0 \cos(\vec{k}x - \omega t)$$

and

$$\vec{H}_z = H_0 \cos(\vec{k}x - \omega t)$$

where E_0: (or H_0) is the electric (or magnetic) field component.

t : time

x : position along the x axis.

$\vec{k}$: a quantity that determines the phase of the waves (propagation phase). $|\vec{k}| = \frac{2\pi}{\lambda}$

ω : angular frequency.

$$\omega = \frac{2\pi}{t}$$ (unit is radian per second) s^{-1} or HZ

Since the frequency is, by definition, the reciprocal of time $\nu = \frac{1}{t}$ (↑ frequency)

Then $\omega = 2\pi\nu$

More commonly, the interaction between EM radiation and matter takes place through the electric component (E). Thus, the plane in which the electric component propagates is defined as <u>the plane of polarization</u>.

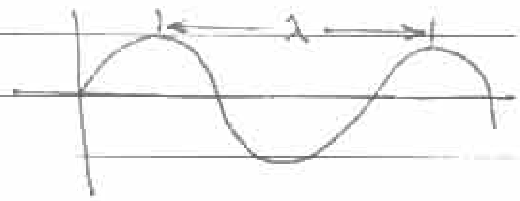
A phase angle could be added to the electric field equation: Φ_0

$$\vec{E}_y = E_0 \cos(\vec{k}x - \omega t + \phi_0).$$

→ Important properties of EM Radiation.

<u>Wavelength</u> (λ) is defined as the distance between two successive peaks or throughs.

λ is related to the frequency (ν) of an EM radiation by :



$\nu \lambda = c$ where c is the speed of EM radiation (speed of light).

<u>units</u> (s^{-1}) (cm) cm/sec.

$c = 299792458$ m/sec
$= 2.998 \times 10^{8}$ m/sec.

<u>Wavenumber</u> ($\bar{\nu}$) is the reciprocal of λ.

$$\bar{\nu} = 1/\lambda = \frac{\nu}{c}$$

$\bar{\nu}$ has the units of cm^{-1}.

→ Speed of Light.

The speed of light in vacuum is c_o

In vaccum $c = c_o$

But in general $c = \frac{c_o}{n}$, because of the fact that light travels slower when it passes thru any medium, like air, than vacuum.

n: is defined as the index of refraction of the propagation medium. $n = \frac{c_o}{c}$.

Note that since the frequency (ν) is independent of the medium the light travels through, the wavelength (λ) is dependent of the phase.

Thus,

$$\lambda = \frac{\lambda_o}{n}$$

and since $\lambda \nu = c$

Then $$\nu \frac{\lambda_o}{n} = \frac{c_o}{n}$$