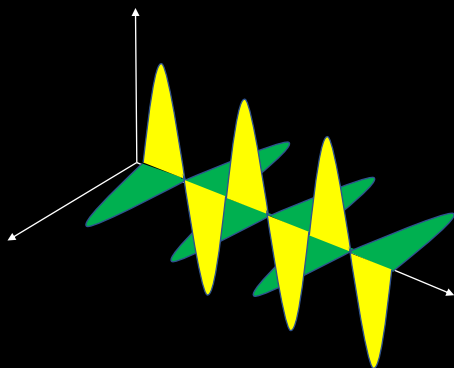


# Electromagnetic Radiation (EMR)



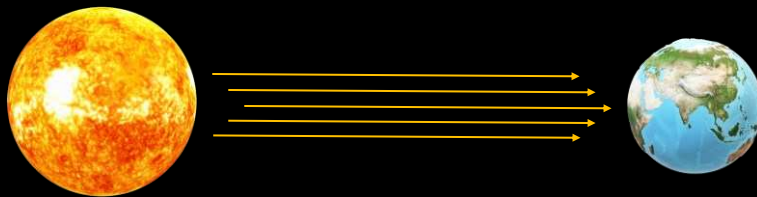
Spectroscopy  
Analysis II | B-7 | L1

Dr. Rajesh Choudhary  
(M.Pharm. Ph.D)

## Electromagnetic Radiation



ⓘ **Electromagnetic radiation (EMR)** is a form of "energy," consists of waves of the electro-magnetic (EM) field, propagating through space, carrying electromagnetic radiant energy.



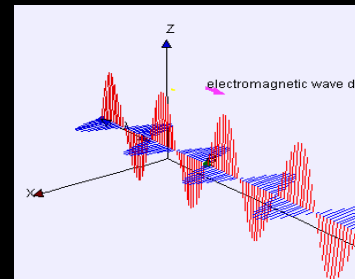
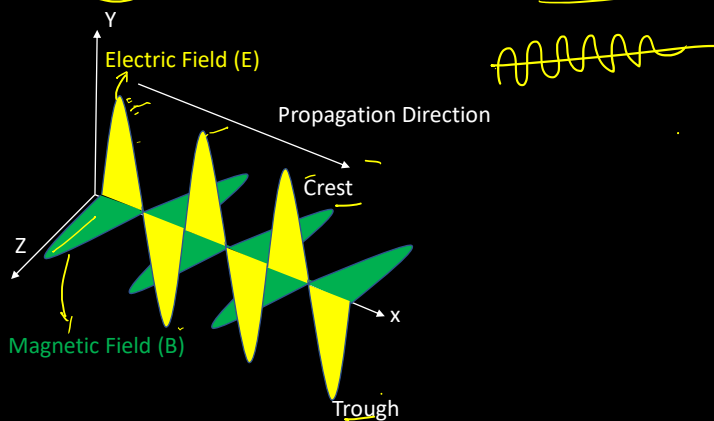
ⓘ It includes radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays. All of these waves form part of the electromagnetic spectrum.

## Electromagnetic Radiation



The Properties of Light or EMR can be explained by two theories; 1) Corpuscular Theory and 2) Wave Theory

According to Wave theory, light/EMR travels in the form of Wave (consisting electrical and Magnetic Field)



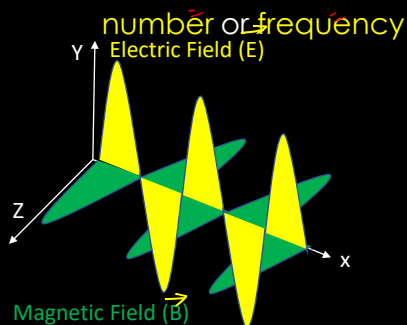
<https://commons.wikimedia.org/w/index.php?curid=16874302>

## Electromagnetic Radiation



### Characteristic Features of EMR-

- Produced by oscillation of electric charges and Magnetic field residing on the atom.  $\vec{E}$  &  $\vec{B}$  are mutually perpendicular to each other and are co-planar.
- They characterized by their wavelength or wave



## Electromagnetic Radiation



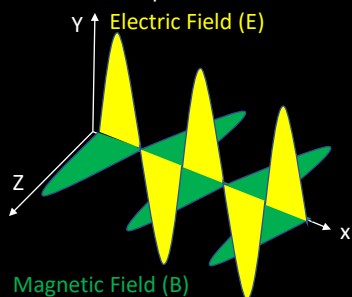
### Characteristic Features of EMR-

3. The energy of an EMR is directly proportional to its frequency

$$E \propto \nu$$

$$E = h \nu$$

The emission or absorption of radiation is quantized and each quantum of radiation is called **Photon**



## Electromagnetic Radiation

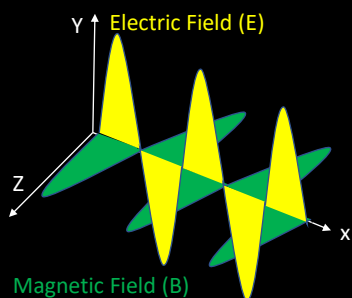


### Characteristic Features of EMR-

4. All type of EMR travel with same velocity (speed of light), no medium is required, it can travel through vacume

$$C_{\text{vacume}} \approx C_{\text{air}}$$

$$2.98 \times 10^{10} \text{ cm/sec}$$

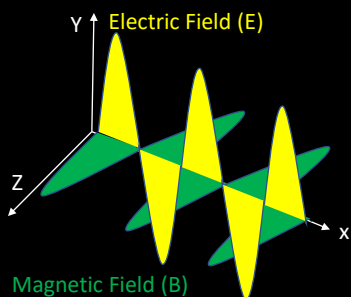


# Electromagnetic Radiation



## Characteristic Features of EMR-

5. When visible light pass through a prism, it is split into 7 colours (VIBGYOR) and having definite wavelength this is called Dispersion Phenomenon. So group of EMR can be split.

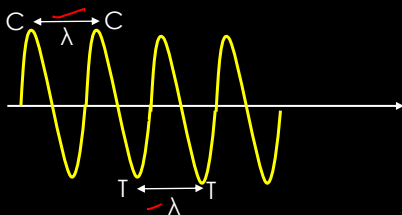


# Electromagnetic Radiation

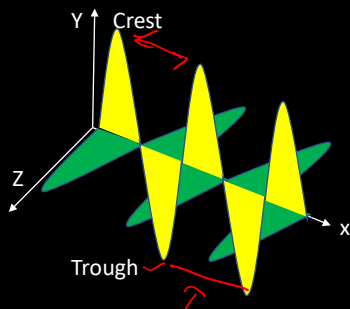


## Fundamental Units

### 1. Wavelength ( $\lambda$ )

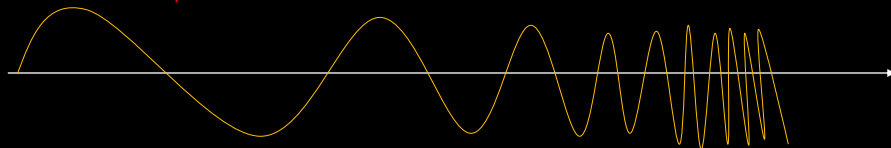


m  
 cm =  $10^{-2}$  m     $\text{\AA}$  =  $10^{-10}$  m  
 $\mu$ m =  $10^{-6}$   
 nm =  $10^{-9}$   
 pm =  $10^{-12}$



$\lambda$ : Distance between two adjacent crests or troughs. expressed in m/cm

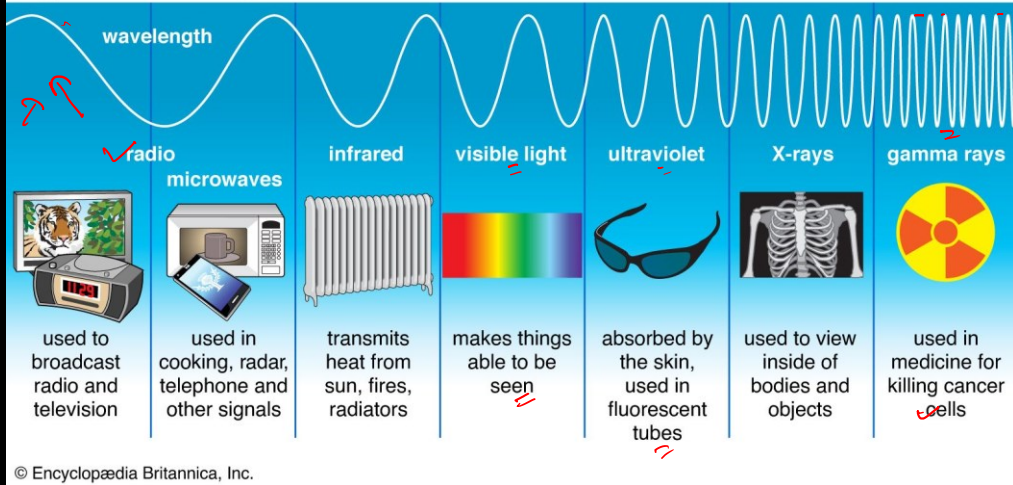
E.g., UV- 200-400 nm    2000 - 4000  $\text{\AA}$   
 Visible- 400-800 nm (violet to red)



# Electromagnetic Radiation



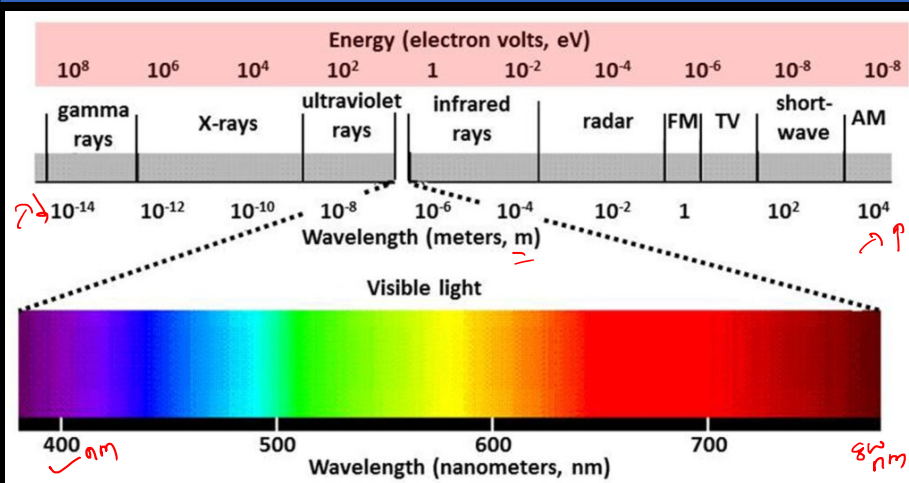
## Types of Electromagnetic Radiation



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<https://www.britannica.com/science/electromagnetic-spectrum>

# Electromagnetic Radiation

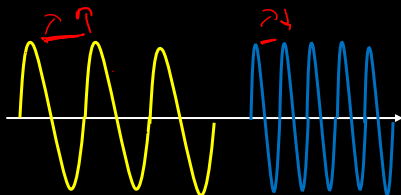


## Electromagnetic Radiation



### Fundamental Units

#### 2. Wave Number ( $\bar{\nu}$ )

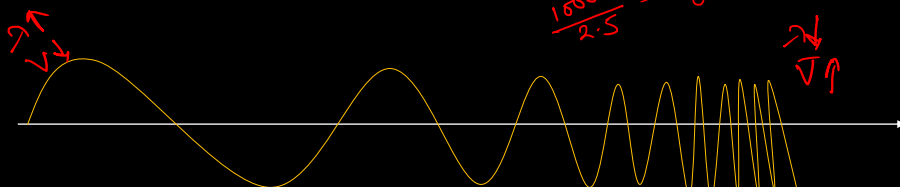


$\bar{\nu}$ : Reciprocal of  $\lambda$ , expressed in  $\text{cm}^{-1}$

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

E.g., IR 2.5 – 25  $\mu\text{m}$  (4000 – 400  $\text{cm}^{-1}$ )

$$\begin{aligned} &+ \\ &2.5 \times 10^{-6} \\ &\frac{1}{2.5 \times 10^{-6} \text{ cm}} \\ &= \frac{10000}{2.5} = 4000 \text{ cm}^{-1} \end{aligned}$$



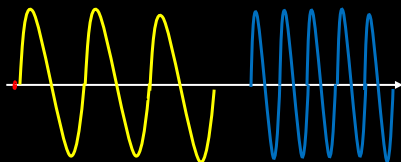
Radio—Microwave—Infrared—visible—UV—X-Ray—Gamma Ray

## Electromagnetic Radiation



### Fundamental Units

#### 3. Frequency ( $\nu$ )



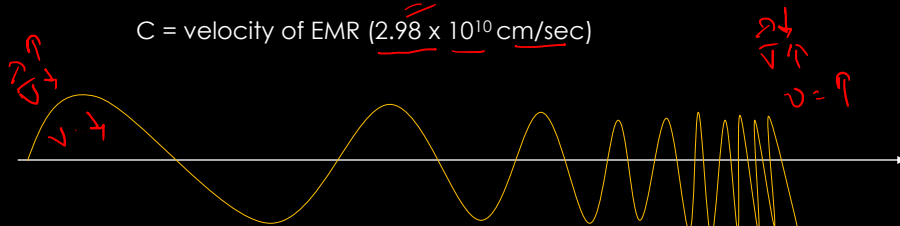
$\nu$ : number of wave which can pass through a point in 1 sec.

expressed as cycle per second (cps) or Hz. 1Hz = 1cps

$$\nu = 1/\lambda$$

$$\nu = C/\lambda$$

C = velocity of EMR ( $2.98 \times 10^{10}$  cm/sec)



Radio—Microwave—Infrared—visible—UV—X-Ray—Gamma Ray

# Electromagnetic Radiation



## Fundamental Units

### 4. Energy

$$E = h\nu$$

$$E = hc/\lambda$$

*(Med)*  
*(vacuum)*

$h$  – Planck Constant ( $6.62 \times 10^{-27}$  erg sec)

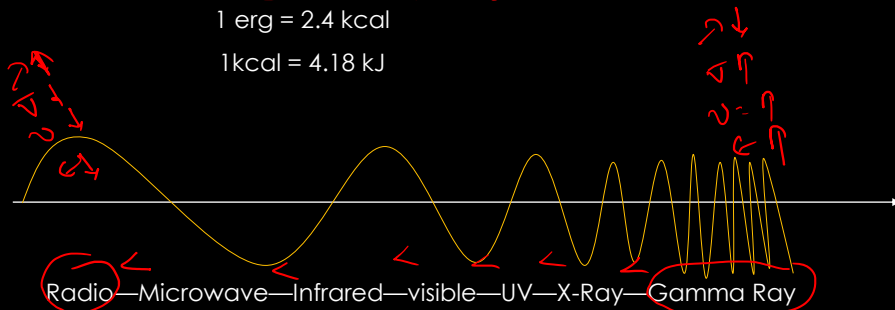
$c$  = velocity of EMR ( $2.98 \times 10^{10}$  cm/sec)

$\lambda$  – wavelength in cm

$$E = 19.72 \times 10^{-17} / \lambda^2 \text{ (GJ)}$$

$$1 \text{ erg} = 2.4 \text{ kcal}$$

$$1 \text{ kcal} = 4.18 \text{ kJ}$$



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