

## Study Guide

### Electromagnetic Waves

#### The syllabus

Chapter–8: Electromagnetic Waves Basic idea of displacement current, Electromagnetic waves, their characteristics, their Transverse nature (qualitative ideas only). Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, X-rays, gamma rays) including elementary facts about their uses.

#### Concepts to be learned

- Basic idea of displacement current,
- Electromagnetic waves,
- Characteristics, of em waves
- Transverse nature (qualitative ideas only).
- Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, X-rays, gamma rays
- Elementary facts about radio waves, microwaves, infrared, visible, ultraviolet, X-rays, gamma rays
- Uses of .radio waves, microwaves, infrared, visible, ultraviolet, X-rays, gamma rays

#### Origin

The **electromagnetic waves** are produced by

- accelerated charges or
- decelerated charges
- Tank circuit or LC circuits

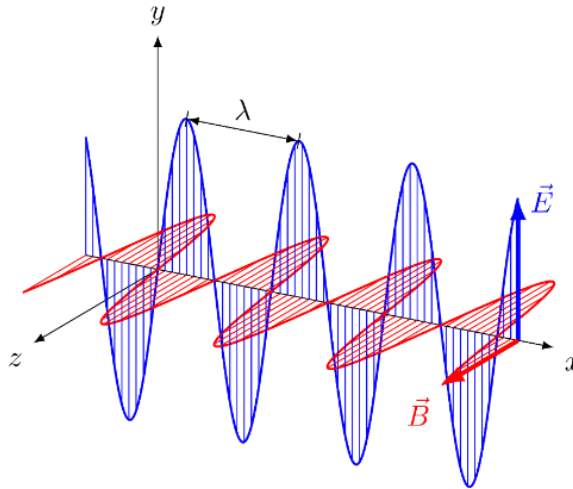
#### Displacement current

The current carried by conductors due to flow of charges is called *conduction current*. The current, through a capacitor in a circuit with varying current, is due to changing electric field (or electric *displacement*, an old term still used sometimes). It is, therefore, called *displacement current* or Maxwell's displacement current

#### The key features of electromagnetic waves are

- **They originate from regularly oscillating electric and magnetic fields**
- **Waves consist of mutually perpendicular and oscillating electric and magnetic field vectors**

- The waves are transverse as the electric and magnetic field vectors are perpendicular to the direction of propagation. -you are familiar with the following diagram from your lesson on electromagnetic waves.

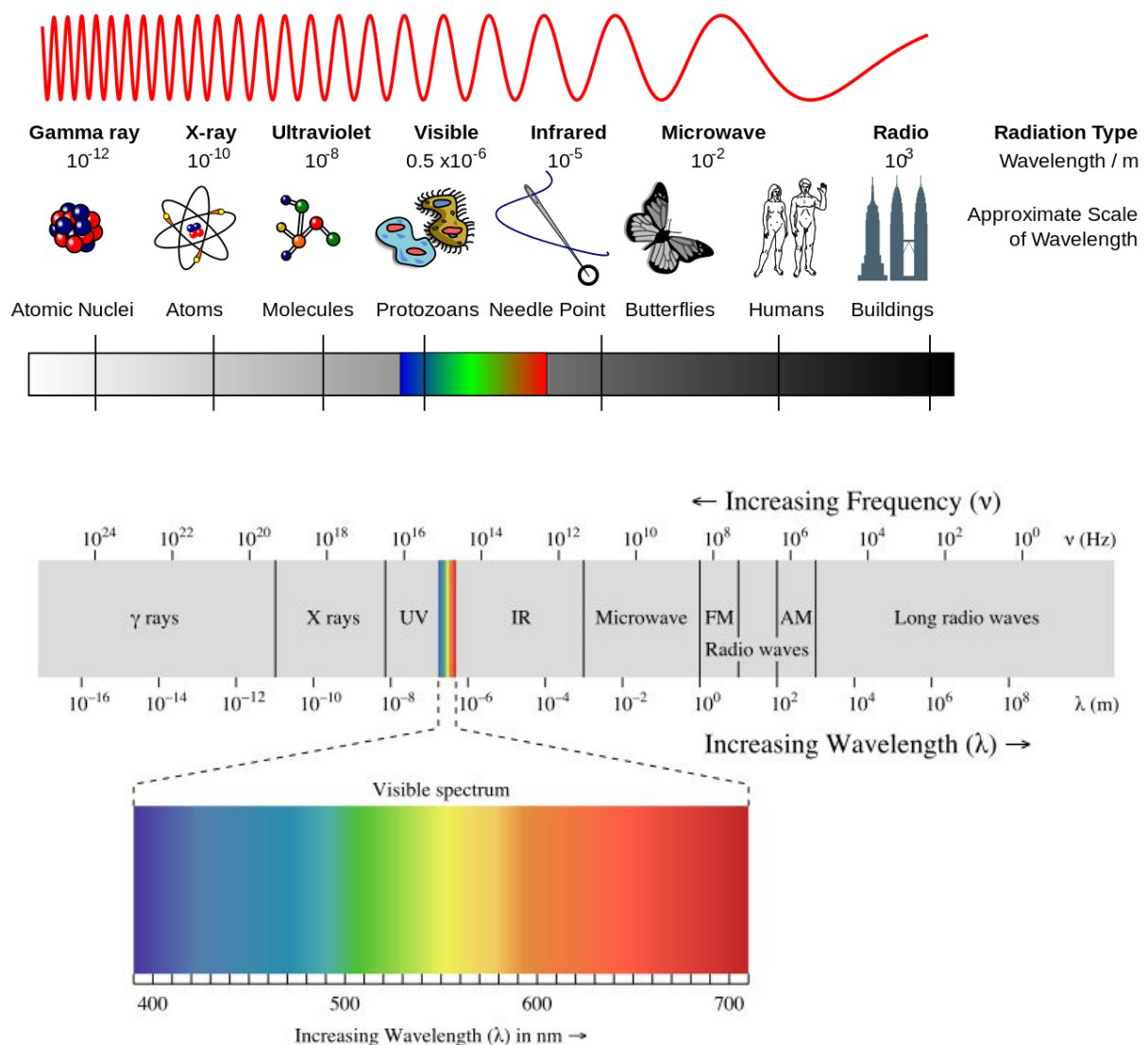


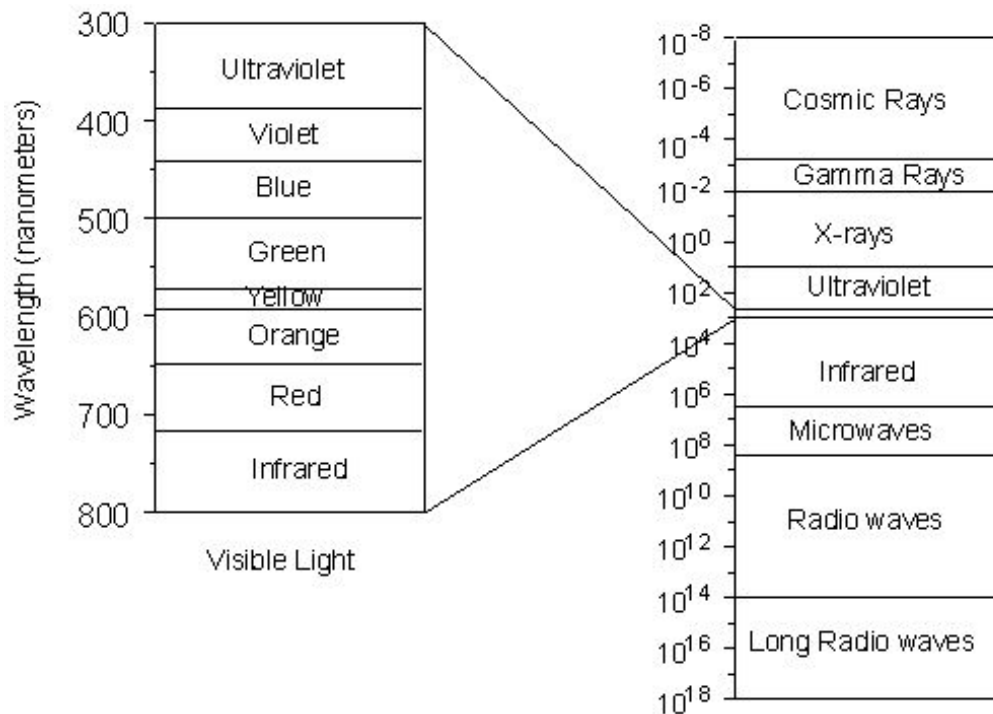
[https://upload.wikimedia.org/wikipedia/commons/thumb/4/40/EM-Wave\\_noGIF.svg/2000px-EM-Wave\\_noGIF.svg.png](https://upload.wikimedia.org/wikipedia/commons/thumb/4/40/EM-Wave_noGIF.svg/2000px-EM-Wave_noGIF.svg.png)

- Electromagnetic waves travel through vacuum at a speed of  $3 \times 10^8$  m/s
- The waves are associated with distinct frequency, dependent upon the frequency of the source
- Electromagnetic waves have a range of frequencies
- Associated with the frequency and the nature of medium through which the wave travels is the wavelength related by  $v = f \lambda$
- The entire electromagnetic spectrum, arranged in order of their frequencies or wavelength is called the electromagnetic spectrum in increasing order of frequency (decreasing order of wavelengths,) the spectrum includes radio waves, infrared radiation, visible light, ultraviolet radiation, x rays and gamma rays.
- Visible light has frequencies between about  $4 \times 10^{14}$  and  $7.9 \times 10^{14}$  Hz
- The human eye and brain perceive different frequencies or wavelengths as different colors
- All electromagnetic waves irrespective of the wavelength band travel with the same speed in vacuum

- The ratio of  $E/B = c$  the velocity of light in vacuum
- Light originates from atoms, due to electron jumps from higher energy states to lower energy states. As changes in electrical and hence magnetic fields are involved, the emanating light wave is electromagnetic and possesses all the features of electromagnetic wave in general.
- In electromagnetic wave the average values of electric energy density and magnetic energy densities are equal
- The electric vector of electromagnetic waves is responsible for special effects

### Electromagnetic Spectrum





## Uses

- **X rays**
  - a) **Medical orthopedic disorders**
  - b) **Stones in kidney and gall bladder**
  - c) **To check metal block defects**
  - d) **Security at airports**
  - e) **Baggage checks at malls ,public places**
  - f) **Study of crystal structures**
- **Gamma rays**
  - a) **Nuclear medicine**
  - b) **Radiotherapy**
  - c) **Sterilization in hospitals**
  - d) **Nuclear reactions**
- **Ultraviolet rays**
  - a) **Provide vitamin D**
  - b) **Used for sterilizing drinking water**
  - c) **Sterilizing medical equipment**
  - d) **Sterilizing equipment's in vanity parlor**

- e) **Forensic work**
- f) **Food preservation**
- **Infrared rays**
  - a) **Night vision**
  - b) **Military Surveillance at borders**
  - c) **Long distance photography**
  - d) **Therapeutic purposes**
- **Radio waves**
  - a) **Radio and television broadcasting**
  - b) **Communication systems**
- **Microwaves**
  - a) **Mobile telephony**
  - b) **Cooking in microwave ovens**

**Make a chart of the uses**