Electromagnetic Waves (EM Waves): Notes for UPSC

Electromagnetic Waves are electromagnetic spectrum in which electric and magnetic field vectors change sinusoidal and are perpendicular to each other and perpendicular to the direction of propagation of waves.

Electromagnetic Waves are a concept found in the General Science section of the UPSC Syllabus.

What are Electromagnetic Waves?

Electromagnetic waves are synchronized oscillations of electric and magnetic fields. The waves travel at the speed of light while in vacuum, the speed being commonly denoted as c. A transverse wave is formed when oscillations of the two fields are perpendicular to each other and perpendicular to the direction of energy and wave propagation, while the material it passes through has a homogeneous composition.

The position of an electromagnetic wave within the spectrum can be characterized by either its frequency of movement to and fro or its wavelength. Electromagnetic waves of different frequencies are called by different names since they have different sources and effects on matter. In order of increasing frequency and decreasing wavelength these are: radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays and gamma rays.

To know more about Nuclear Fuel Cycles, visit the linked article.

How are Electromagnetic Waves emitted?

Electromagnetic waves are formed by particles undergoing acceleration that will be electrically charged thus enabling them to exert force on other charged particles by interacting with them. EM waves carry energy, momentum and angular momentum away from their source particle and can impart those quantities to matter with which they interact. Electromagnetic radiation is associated with those EM waves that are free to propagate themselves ("radiate") without the continuing influence of the moving charges that produced them, because they have achieved sufficient distance from those charges.

What are the effects of Electromagnetic Waves?

The effects of Electromagnetic Waves (EMW) upon chemical compounds and biological organisms depend both upon the power and its frequency. EMW of visible or lower frequencies (i.e., visible light, infrared, microwaves, and radio waves) is called non-ionizing radiation,

because its photons do not individually have enough energy to ionize atoms or molecules or break chemical bonds. The effects of these radiations on chemical systems and living tissue are caused primarily by heating effects from the combined energy transfer of many photons.

Questions related to Electromagnetic Waves

What are electromagnetic waves and its properties?

These are waves that consist of vibrating electric and magnetic fields. They transmit energy through matter or across space. Some electromagnetic waves are generally harmless. Like other waves, electromagnetic waves have properties of speed, wavelength, and frequency.

How electromagnetic waves are produced?

An electromagnetic wave can be created by accelerating charges; moving charges back and forth will produce oscillating electric and magnetic fields, and these travel at the speed of light.

What is the use of electromagnetic waves?

Electromagnetic waves are used to transmit long/short/FM wavelength radio waves, and TV/telephone/wireless signals or energies. They are also responsible for transmitting energy in the form of microwaves, infrared radiation (IR), visible light (VIS), ultraviolet light (UV), X-rays, and gamma rays.

Which is a characteristic of an electromagnetic wave?

Electromagnetic waves are transverse waves, similar to water waves in the ocean or the waves seen on a guitar string. This is as opposed to the compression waves of sound.

How electromagnetic waves affect humans?

At low frequencies, external electric and magnetic fields induce small circulating currents within the body. The main effect of radio frequency electromagnetic fields is heating of body tissues. There is no doubt that short-term exposure to very high levels of electromagnetic fields can be harmful to health.

The World Health Organization has classified radio frequency radiation emanating from electromagnetic waves as Group 2B - possibly carcinogenic. This group contains possible carcinogens such as lead, DDT, and styrene.