

# **General Physics**

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**1 nd Class**

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*Electromagnetic Radiation*

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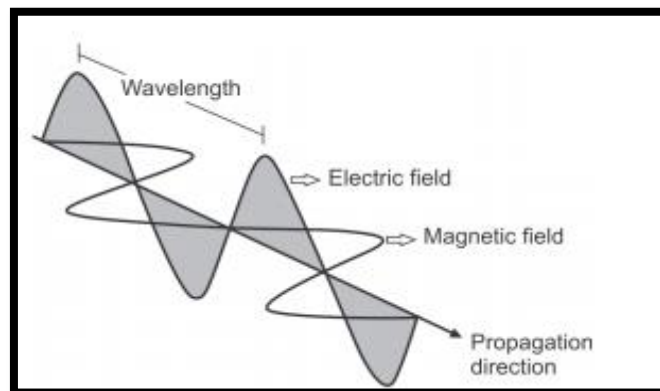
## ***Radiation***

Radiation is a fact of life: all around us, all the time. Radiation is energy moving in the form of waves or streams of particles. Understanding radiation requires basic knowledge of atomic structure, energy and how radiation may damage cells in the human body. The radiation has many other forms. Sound and visible light are familiar forms of radiation; other types include ultraviolet radiation (that produces a suntan), infrared radiation (a form of heat energy), and radio and television signals.

## **Electromagnetic Radiation**

It is the process by which heat energy is transmitted from one place to another without the aid of any material medium. When a body has internal energy, its atoms and molecules vibrate and emits electromagnetic radiation, which can transport energy across a vacuum, e.g. heat reaches the earth from the sun.

Electromagnetic radiation consists of oscillating electric and magnetic fields (see Figure 3). An electromagnetic wave requires no medium for propagation; that is, it can travel in a vacuum as well as through matter.



**Figure 1: Electromagnetic wave**

Electromagnetic radiation is a form of energy. Electromagnetic energy is the term given to energy traveling across empty space and used to describe all the different kinds of energies released into space by stars such as the Sun. These kinds of energies include some that you will recognize and some that will sound strange. They include:

- Radio Waves
- TV waves
- Radar waves
- Microwaves, like in a microwave oven
- Heat (infrared radiation)
- Light
- Ultraviolet Light (This is what causes Sunburns)
- X-rays (emitted by X-ray tubes)
- Gamma Rays; gamma rays (emitted by radioactive nuclei) have essentially the same properties of X-rays and differ only in their origin.

**Table 1: Electromagnetic spectrum**

| Electromagnetic | Wavelength           | Frequency                                    | Energy      |
|-----------------|----------------------|--|-------------|
| Radio waves     | 30-6 m               | 10-50 MHz                                    | 40-200 neV  |
| Infrared        | 10-0.7 $\mu\text{m}$ | 30-430 THz                                   | 0. 2-1.8 eV |
| Visible light   | 700-400 nm           | 430-750 THz                                  | 1.8-3eV     |
| Ultraviolet     | 400-100 nm           | 750-3000 THz                                 | 3-12 eV     |
| X- and gamma    | 60-2.5 pm            | $5 \times 10^6 - 120 \times 10^6 \text{THz}$ | 20-500 keV  |

## Electromagnetic spectrum

Electromagnetic spectrum includes radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, gamma rays and cosmic rays (Figure 2). All of them travel at a velocity ‘c’ ( $3 \times 10^8 \text{ m.s}^{-1}$ ) in a vacuum. The wavelength and photon energy of the whole range of electromagnetic radiation are summarized in Table 1.

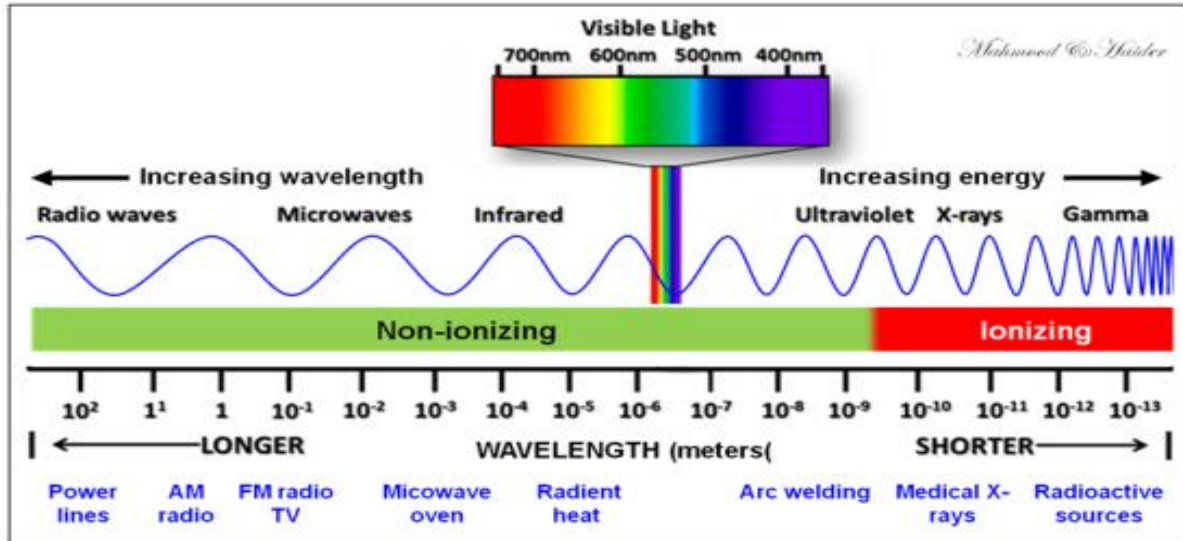


Figure 2: The electromagnetic spectrum

## Types of Radiation

Not all radiation interacts with matter in the same way. There are two forms of radiation:

### 1-Non-Ionizing Radiation

Non-ionizing radiation is the radiation that has enough energy to move atoms in a molecule around or cause them to vibrate, but not enough to remove electrons. That mean it does not possess enough energy to produce ions.

- Non-ionising radiation consists of parts of the electromagnetic-spectrum (Figure 4), which includes radio waves, microwaves, infra-red, visible and ultraviolet light, together with sound and ultrasound. Cellular telephones, television stations, FM and AM radio, and cordless phones use non-ionizing radiation.
- Other forms include the earth's magnetic field, as well as magnetic field exposure from proximity to transmission lines, household wiring and electric appliances. These are defined as extremely low-frequency (ELF) waves and are not considered to pose a health risk.

## 2-Ionizing Radiation

Ionizing radiation is a special type of radiation (in the form of either particles or waves) that has enough energy to remove tightly bound electrons out of their orbits around atoms, thus creating ions, the atom is said to be ionized. This process is called ionization.

- Ionizing radiation includes the radiation that comes from both natural and man-made radioactive materials. Examples of this kind of radiation of interest for the purpose of this course are gamma ( $\gamma$ ) and x-rays. Gamma radiation consists of photons that originate from within the nucleus, and X-ray radiation consists of photons that originate from outside the nucleus, and are typically lower in energy than gamma radiation. We take advantage of its properties in diagnostic imaging, to kill cancer cells, and in many manufacturing processes.
- Ionizing radiation can occur in one of two forms: particulate or electromagnetic . Particulate ionizing radiation is emitted when components of the structure of an atom are ejected, artificially or naturally.