

## **Electromagnetic Spectrum: X-rays**

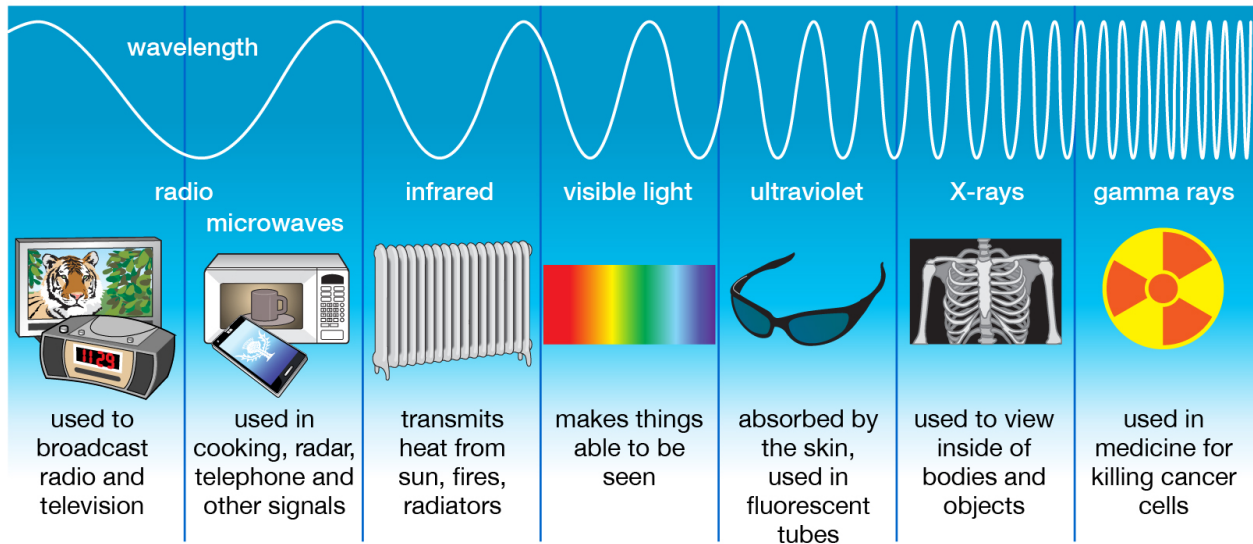
The electromagnetic spectrum includes all kinds of light, even the ones that human eyes cannot perceive. The lights that make up the rainbows are only a tiny portion of the electromagnetic spectrum. There are different types of rays that fall into the electromagnetic spectrum, such as radio waves, microwaves, gamma rays, UV rays, and X-rays. All these lights that I just mentioned are invisible to human eyes. X-rays are part of the electromagnetic spectrum with a very particular wavelength. The wavelength of X-rays is between 0.01nm-10nm. The frequency range of X-rays lies between 30 PHz to 30 Ehz. The energy of X-rays ranges from 100eV to 100keV. X-rays are mostly used for their power to penetrate condensed matters like human skin, bones, and flesh. In the medical department, an X-ray is one of the most common names that is used to get a better picture of the insides. X-ray has been first discovered by a German physicist, Wilhelm C Roentgen in 1895.

### **Different Types of Rays**

The categorization of the electromagnetic waves is based on their wavelengths, frequencies, and energy levels. Though all of the electromagnetic waves travel at the speed of light in vacuum, they have variable wavelengths. In order of their ascending frequency and descending wavelengths, different types of rays can be sorted like this- radio waves, microwaves, infrared radiation, visible light, ultraviolet rays, X-rays, and gamma rays.

- Wavelengths ranging from one meter to one millimeter and frequency between 0.3GHz to 300GHz are called radio and microwaves.
- Infrared waves can be sorted into three categories i.e., near, short, mid, long, and far wavelength infrared. The wavelengths of these infrared rays are- near (0.75-1.4 $\mu$ m), short (1.4-3 $\mu$ m), mid (3-8 $\mu$ m), long (8-15 $\mu$ m), far (15-1000 $\mu$ m).
- Electromagnetic radiation that has a wavelength between 400-700nm can be detected by the human eye and therefore called the visible light.
- Ultraviolet rays have their wavelength between 100-400nm.
- X-rays and gamma rays have a wavelength between 0.01 to 10 nm.

## Types of Electromagnetic Radiation



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## Property of X-rays

X-ray photons carry an abundant amount of energy that is able to ionize atoms and disrupt the molecular bonds. X-ray has a shorter wavelength than that of the visible light. Hard X-rays can penetrate dense objects without getting much scattered. The penetration depth varies according to the magnitude of the x-ray spectrum..

## Types of X-Rays

Based on energy level, there are different types of rays that fall into the x-ray domain- Hard X-rays and Soft X-rays.

- Hard X-Rays- Energy between 5-10keV, wavelength below 0.1 nm
- Soft X-Rays- Energy between 100eV-5keV, wavelength between 0.1nm-10nm.

Hard x-rays and gamma rays are often confused. The distinction is that gamma rays are produced from the nucleus of atoms, but the x-rays are produced from the electron of the atoms.

## Uses of X-rays

As mentioned earlier, X-rays are heavily used in the medical domain as it can penetrate hard and condense matters like human skin, flesh, and bones. There are other uses as well such as

1. **Broken Bones**- X-rays are used to take photographs of broken bones of the human body.
2. **Radiation Therapy**- If a patient is diagnosed with cancer, the x-ray can be used for radiation therapy.
3. **Airport Security**- For the properties of an x-ray, in the airport, it is used to scan people and their baggage for security purposes.

4. **Revealing Counterfeit Art-** X-rays are also used to correctly infer the originality of paintings and architectures.