LESSON 1

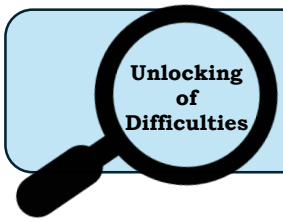
# ELECTROMAGNETIC WAVES

***MELC:*** *Compare the relative wavelengths of different forms of electromagnetic waves.*

***Objectives:***

1. Define wavelength
2. Illustrate wavelengths of Low and High Frequency EMS
3. Compare wavelengths of different forms of Low Frequency and High Frequency EMS

## Let's Discover!




Electromagnetic (EM) wave is a disturbance in a field that carries energy and does not require a medium to travel.

In this lesson, we will explore the fascinating world of electromagnetic (EM) waves and how their wavelengths differ. **Electromagnetic waves** are all around us, from the visible light that helps us see to the radio waves that allow us to communicate over long distances. As we go through this lesson, you will understand the different types of electromagnetic waves, how they compare in terms of wavelength, and how these waves impact our daily lives here in the Philippines.

In the morning, you are often woken by sunlight streaming through your windows. For many of us, this is a signal to start the day and prepare for school. As part of your morning routine, you might boil water for a warm cup of milk or toast bread in an electric toaster for breakfast.

At home, with just the press of a button on your remote control, you can enjoy your favorite TV shows or catch up on the news. When you visit malls, turning faucets on and

off has become effortless—you simply place your hands under the sensor, and water flows out, stopping automatically when you remove your hands.

But did you know that electromagnetic waves play a role in all these activities? What exactly are electromagnetic waves? How are they produced?

The electromagnetic spectrum is a broad range of EM waves, from those with the longest wavelengths, like radio waves, to those with the shortest wavelengths, like gamma rays. Each type of wave has unique properties and applications.

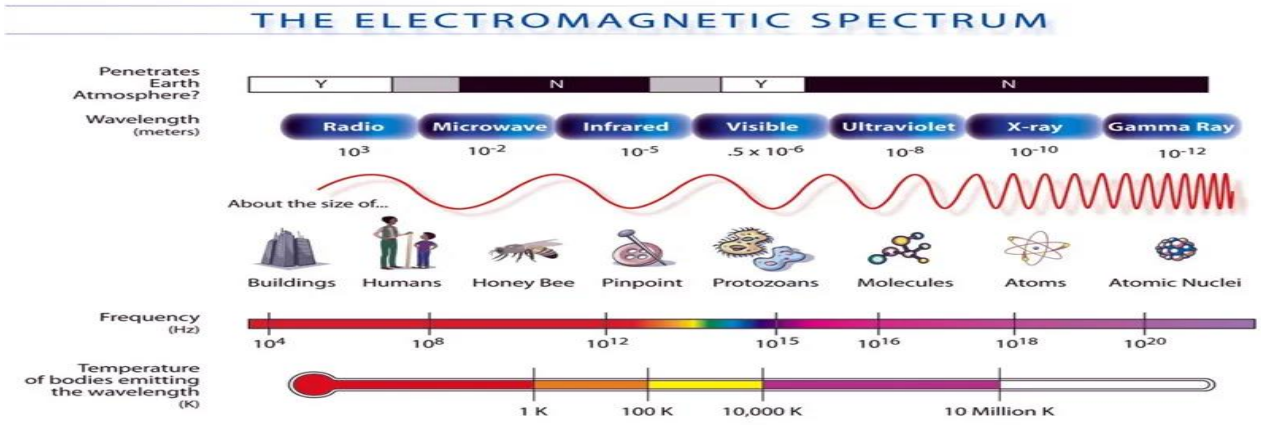



***Figure 1:*** Electromagnetic Spectrum
***Source:*** https://scied.ucar.edu/learning-zone/earth-system/electromagnetic-spectrum

For example, radio waves, which have the longest wavelengths, play a significant role in local radio and TV broadcasting. In a nation as geographically diverse as the Philippines, radio waves are crucial for communication, especially in remote areas where they often serve as the only means of mass communication. Radio waves have wavelengths that can range from as small as 1 millimeter (0.001 meters) to as large as 100 kilometers (100,000 meters), with frequencies between 3 kHz and 300 GHz. These characteristics allow them to cover vast distances, making them ideal for broadcasting and long-range communication.


***Figure 2:*** Practical Applications of Electromagnetic Waves

Microwaves, on the other hand, have shorter wavelengths than radio waves. These waves are commonly used in a variety of technologies, including microwave ovens

for cooking food, Wi-Fi signals for internet connectivity, and satellite communications. With wavelengths ranging from 1 millimeter (0.001 meters) to 1 meter and frequencies between 300 MHz and 300 GHz, microwaves are versatile and widely applied in modern technology.

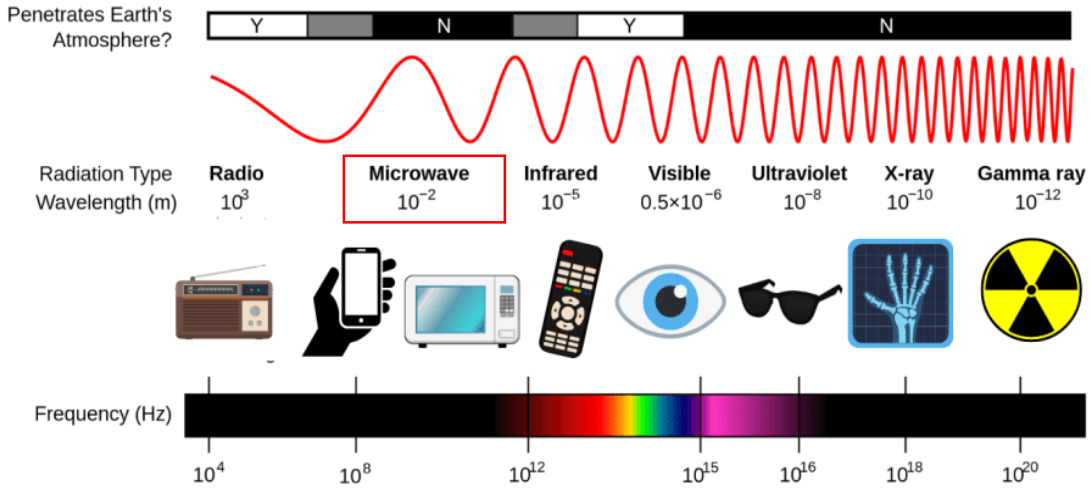



***Figure 4:*** Microwave

Moving further along the spectrum, infrared waves have even shorter wavelengths and are commonly used in everyday devices such as remote controls and thermal imaging cameras. These cameras played an instrumental role in recent volcanic eruptions in the Philippines by monitoring heat signatures from the ground. Infrared waves have wavelengths between 700 nanometers ($7 \times 10^{-7}$ meters) and 1 millimeter (0.001 meters) and frequencies from 300 GHz to 400 THz. Their ability to detect heat makes them valuable in various applications, from household electronics to geological monitoring.

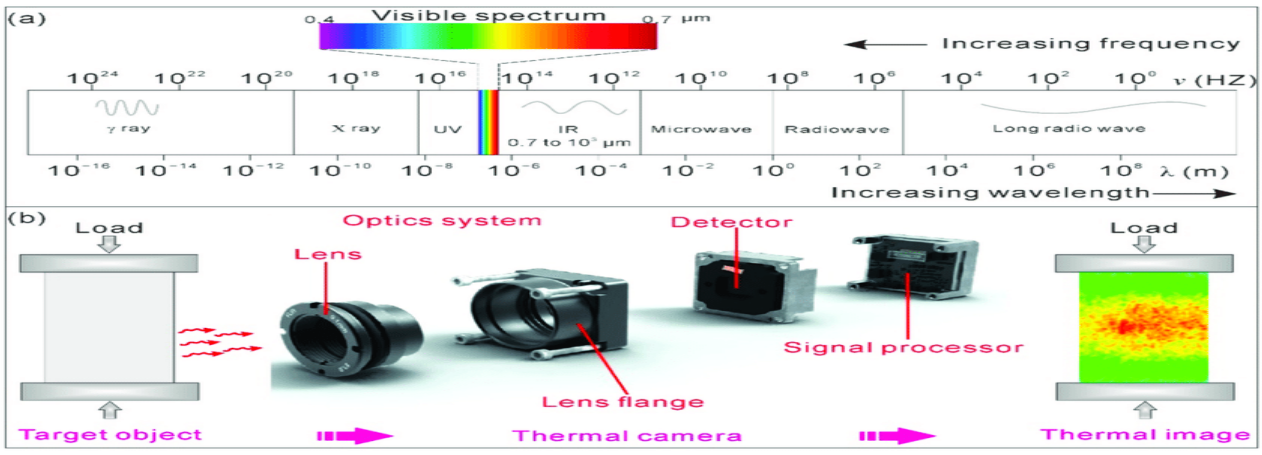



***Figure 4:*** Infrared
***Source:*** https://www.researchgate.net/figure/a-Electromagnetic-spectrum-and-infrared-IR-band-b-The-basic-working-principle-of-a_fig2_338366994

In the middle of the spectrum lies visible light, the only type of electromagnetic wave that humans can see with the naked eye. The sunlight we enjoy during the day is a natural source of visible light, providing the energy necessary for life on Earth. Visible light has wavelengths ranging from 400 to 700 nanometers ($4 \times 10^{-7}$ to $7 \times 10^{-7}$ meters) and frequencies between 430 THz and 770 THz. It is this visible spectrum that allows us to perceive the world around us, from the colors of a rainbow to the brightness of a sunny day.

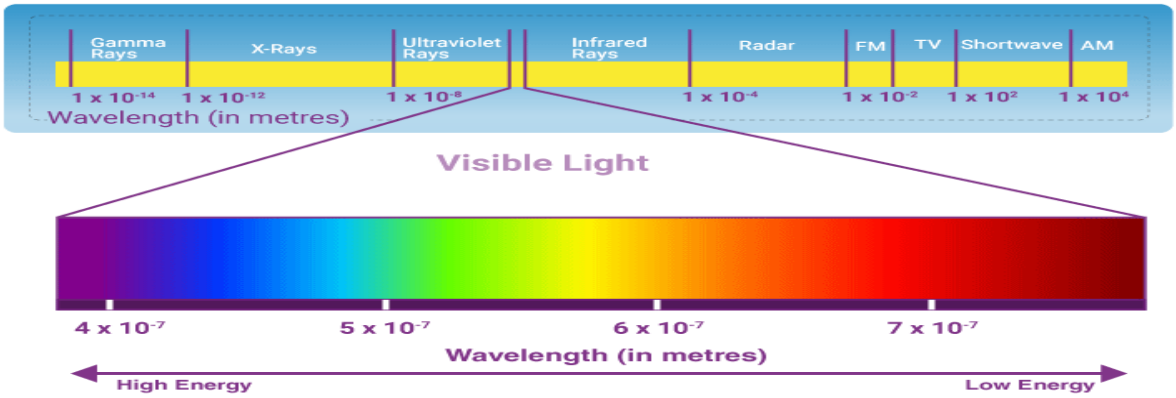



***Figure 5:*** Visible light
***Source:*** https://byjus.com/physics/visible-light/

As we move toward shorter wavelengths, ultraviolet (UV) rays, X-rays, and gamma rays become increasingly energetic. These high-frequency waves have significant implications for health, medicine, and technology. Ultraviolet rays, for instance, are known for causing sunburn, but they are also used in water purification systems in rural areas of the Philippines where access to clean water is limited. UV rays have wavelengths ranging from 10 nanometers ($1 \times 10^{-8}$ meters) to 400 nanometers ($4 \times 10^{-7}$ meters) and frequencies between 750 THz and 30 PHz. Their ability to sterilize water has made them a valuable resource in providing safe drinking water to communities in need.

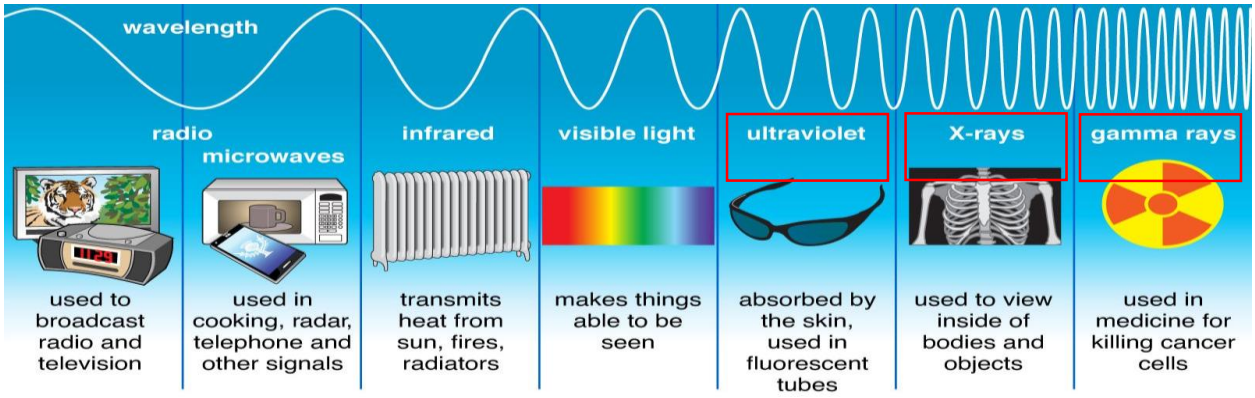



***Figure 6:*** Ultraviolet, X-ray and Gamma Rays

X-rays are another high-frequency wave that plays a crucial role in medical diagnostics. By allowing doctors to see inside the human body without surgery, X-rays have revolutionized healthcare. These waves have wavelengths ranging from 0.01 nanometers ($1 \times 10^{-11}$ meters) to 10 nanometers ($1 \times 10^{-8}$ meters) and frequencies from 30 PHz to 30 EHz, enabling them to penetrate various materials, including human tissue, to produce detailed images.

***Figure 7:*** X-ray
***Source:*** https://www.cdc.gov/radiation-health/data-research/facts-stats/x-rays.html

Lastly, gamma rays, with their extremely short wavelengths and high energy, are used in advanced medical treatments such as radiotherapy for cancer. Gamma rays have wavelengths shorter than 0.01 nanometers (less than $1 \times 10^{-11}$ meters) and frequencies above 30 EHz. Their ability to destroy cancer cells makes them a powerful tool in the fight against life-threatening diseases.

***Figure 8:*** Gamma rays

In your learning activity sheet, the Electromagnetic Spectrum (EMS) is divided into two categories: Low-Frequency EM Waves, which include radio, microwave, infrared, and visible light, and High-Frequency EM Waves, which encompass ultraviolet rays, X-rays, and gamma rays. This lesson has focused on the Low-Frequency EM Waves, discussing their wavelengths and applications. By understanding the properties of these waves, you can better appreciate how they are integrated into technologies that make life more convenient and connected, particularly here in the Philippines. From the radio broadcasts that reach even the most remote areas to the thermal imaging cameras that help monitor volcanic activity, electromagnetic waves are a vital part of our everyday lives.