LUMITEX™

Visible Light Spectrum

From a Lighting Manufacturer's Perspective

Introduction

The electromagnetic (EM) spectrum is the range of all types of electromagnetic radiation. It encompasses the entire range of light. Most of which is invisible to the naked eye. From Gamma rays on the left of the visible spectrum to long radio waves on the right.

As a leading lighting manufacturer, we find the science and technology of light both fascinating and essential. In this article, I'll cover Visible light; and where it falls on the electromagnetic spectrum, its characteristics, and applications.

The EM spectrum of light includes a range of light waves. One of lights characteristics is how it behaves like a wave with its peaks and valleys, or crest (highest point) and trough (lowest point). Because of this attribute, light can be defined by its wavelength.

What are Wavelengths?

A wavelength is the horizontal distance between the two peaks of the wave. Light is measured by its wavelength (in nanometers). It is usually characterized by the Greek symbol λ.

Visible light is usually defined as having wavelengths in the range of 400–700 nanometers (nm) or one billionth of a meter.

EM waves are categorized according to their wavelengths and frequencies (number of waves passing a point in a certain time). This classification determines if the electromagnetic radiation sits to the left or right of the Visible spectrum.

Light is energy that will take on different forms.

Here's what I mean...

The image below details the electromagnetic spectrum with light highlighted. (Noted as Visible spectrum)

Visible light represents a small fraction of the entire EM spectrum.

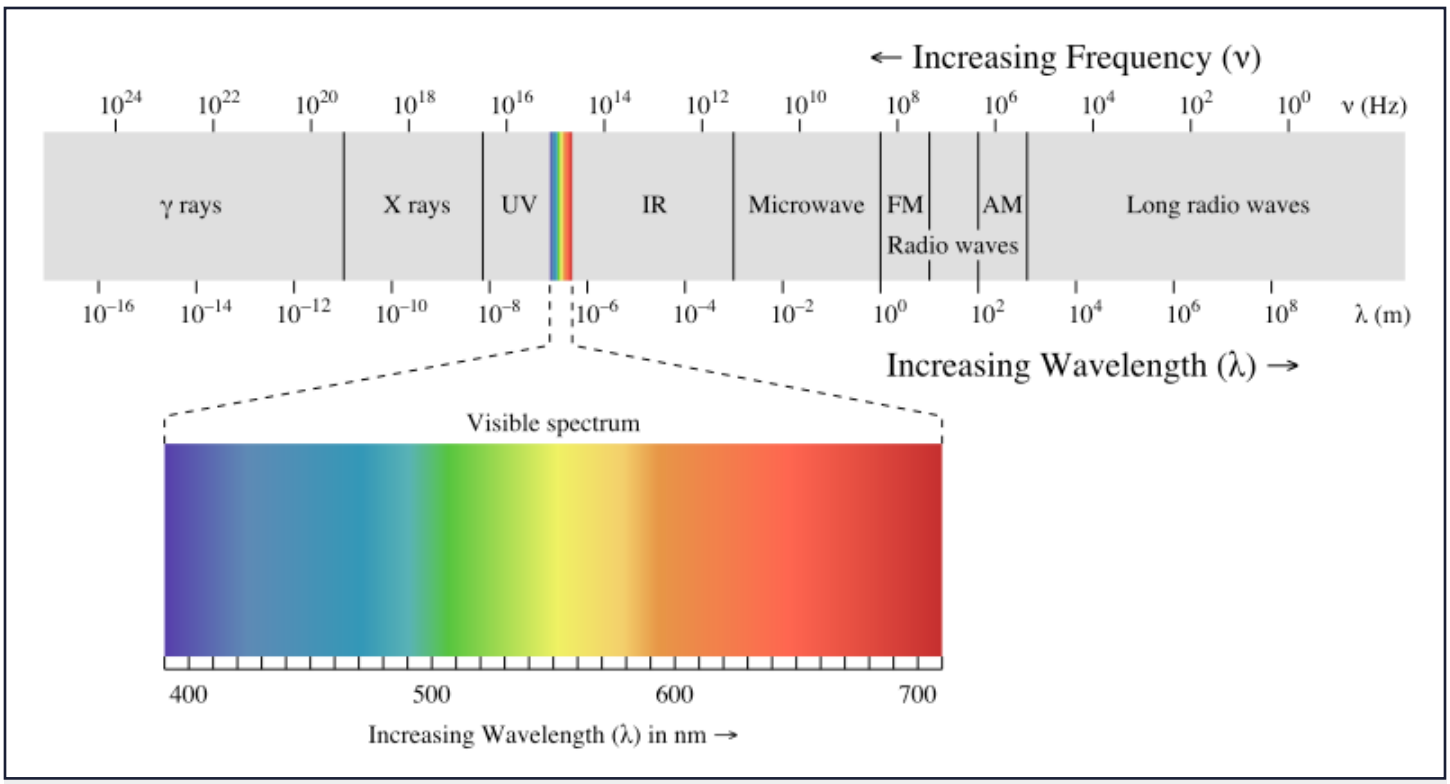

Image Credit: [Electromagnetic spectrum]

If you look at the left of the visible spectrum...

These types of radiation are harmful to living organisms, due to their extremely high frequencies. You'll find Gamma rays, X-Rays and Ultraviolet rays categorized here.

Gamma Rays - the highest in frequency and energy, are the most damaging.

X-Rays - also a wave of high energy and short wavelength. Most X-Rays have a wavelength ranging from .01 to 10 nanometers.

UV (ultraviolet rays) - is an electromagnetic radiation with a wavelength from 10 nm to 400 nm, shorter than that of visible light but longer than X-rays. Light with a wavelength immediately shorter than any light in the visible spectrum is called Ultraviolet Light.

Visible spectrum - The visible spectrum of light is the section of the electromagnetic spectrum that is visible to the human eye. (more on that in a second).

Now to the right of the visible spectrum...

IR - Infrared rays - Heat waves given off by thermal bodies. They are released by heat or thermal energy.

Microwave - In communication, it is used in radar. You most likely know it for warming your food.

Radio Waves - An electromagnetic wave of frequency, used for long distance communication. It has the lowest energy levels.

Long Radio Waves - are between 30 KHz to 279 KHz having an average wavelength of 1500 meters. On the other hand, Shortwaves range between 1.5MHz to 30MHz (wavelength is between 10 to 85 meters.)

All radio waves, short or long, belong to electromagnetic radiation like the light. More differences between shortwave vs. longwave radio.

Now that we understand the full spectrum, let's breakdown the "center stage"...

Visible Light...

What is Visible Light in the Electromagnetic Spectrum?

Visible light sits in the region with ultraviolet (UV) to the left of the spectrum and infrared (IR) to the right. It is a form of electromagnetic radiation which can be subdivided into seven colors.

It's probably the most familiar to you because it is the only region on the spectrum that is visible to most human eyes.

"This part of the spectrum includes a range of different colors that all represent a particular wavelength. Rainbows are formed in this way; light passes through matter in which it is absorbed or reflected based on its wavelength. Thus, some colors are reflected more than others, leading to the creation of a rainbow." [Source]

One of the most important characteristics of Visible light is color.

Colors of the Visible Light Spectrum

There are seven wavelength ranges in the visible spectrum that coordinate to a different color. Each visible color has a wavelength. As you move from red to violet, the wavelength decreases and energy increases.

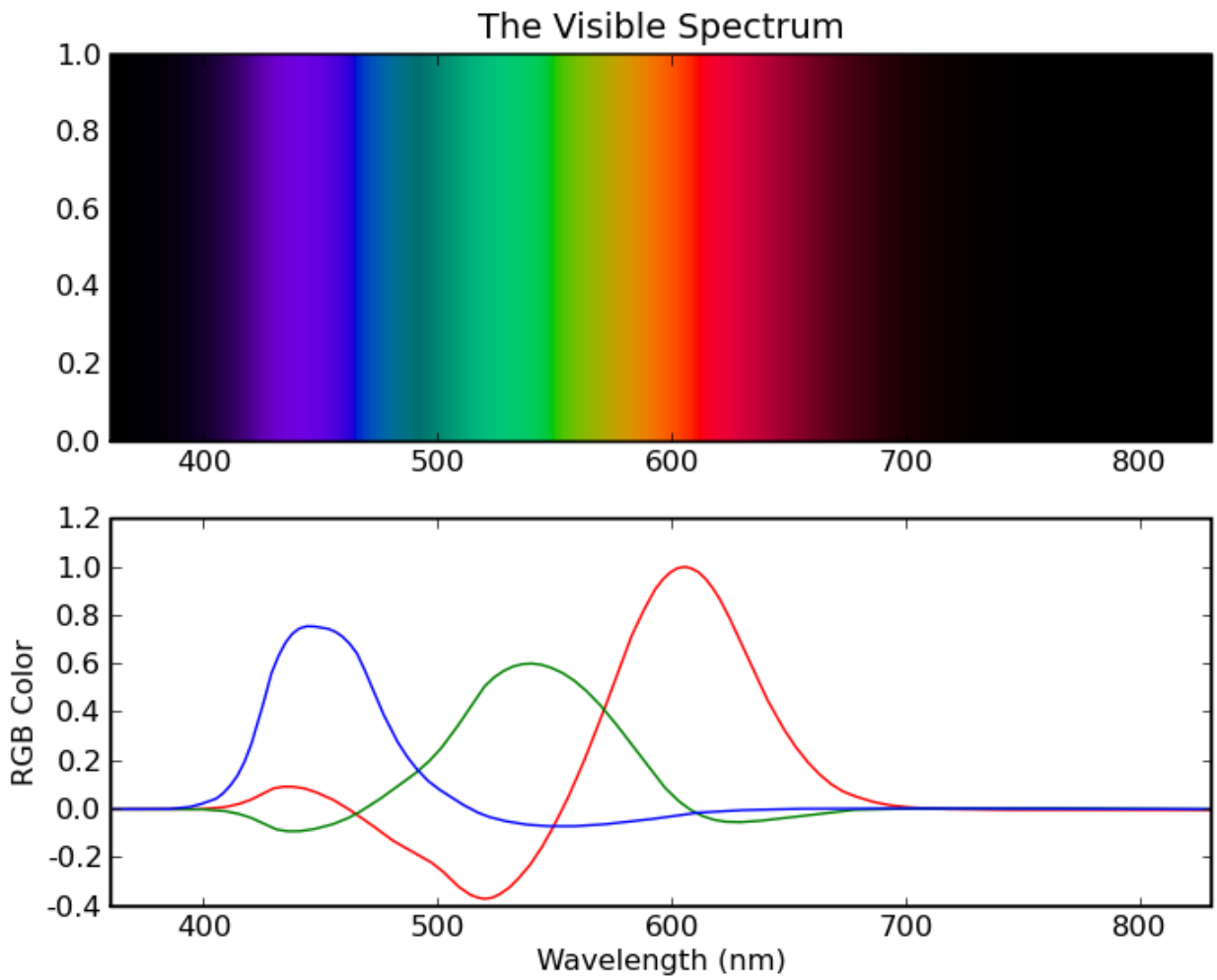

Image Credit: Visible Spectrum

Here are the 7 from shortest to longest wavelength.

Violet - shortest wavelength, around 400-420 nanometers with highest frequency. They carry the most energy.
Indigo - 420 - 440 nm
Blue - 440 - 490 nm
Green - 490 - 570 nm
Yellow - 570 - 585 nm
Orange - 585 - 620 nm
Red - longest wavelength, at around 620 - 780 nanometers with lowest frequency

UV Light located next to visible light on the spectrum has higher frequency which equates to higher radiation. If you ever had a sun burn, it was due to ultraviolet radiation emitted by the sun. The uses for UV light go far beyond the summer tan.

Applications Utilizing UV Light

The uses for ultraviolet light are broad and diverse. From tanning beds to bacteria disinfection to infection control.

Hospitals use UV lamps to sterilize its surgical equipment that will help reduce infections.

According to John Hageman, MS, CHP, Radiation Safety Officer at Southwest Research Institute, "Sterilization, the killing of bacteria (or any types of cells), on medical instruments is primarily achieved by the radiation causing severe damage to the cell's components and to the cell's chromosomes, specifically the DNA.

"Severe damage" to DNA is multiple breaks in the long DNA ladder-like structure. Radiation (for example, gamma rays, x rays, or beta and alpha radiation) has enough energy to ionize atoms and molecules; that is, it can create charged particles and free radicals."

On the other side, next to the visible light spectrum is the (IR) infrared radiation...

These waves are longer than those of visible light, but shorter than radio waves. The longer infrared waves can be sensed as heat. This form of light is invisible to the human eye and carries a variety of applications as well.

Applications Utilizing Infrared Energy

Among the most well-known are remote controls, thermal imaging and night vision.

A remote control uses light waves to change the channels. It uses infrared light, transmitted with light-emitting diodes (LEDs) to send a signal to your device or television.

“Thermal imaging is a method of improving visibility of objects in a dark environment by detecting the objects’ infrared radiation and creating an image based on that information. Thermal imaging, near-infrared illumination, low-light imaging are the three most commonly used night vision technologies.”

IR communication can be used anywhere as it is not harmful to humans.

Light is electromagnetic radiation. It moves in waves and is produced from a source.

As a supplier for lighting solutions, it’s easier to break it down into different sources of light and where they fall in the grand scheme of things on the electromagnetic spectrum.

Sources of Visible Light

The chart below shows different types of lights and how they affect the way our eyes view colors. For example in daylight, we can see blue and green the most. Daylight also gives more intense but cooler light. In fluorescent lighting, green and red colors have high visibility.

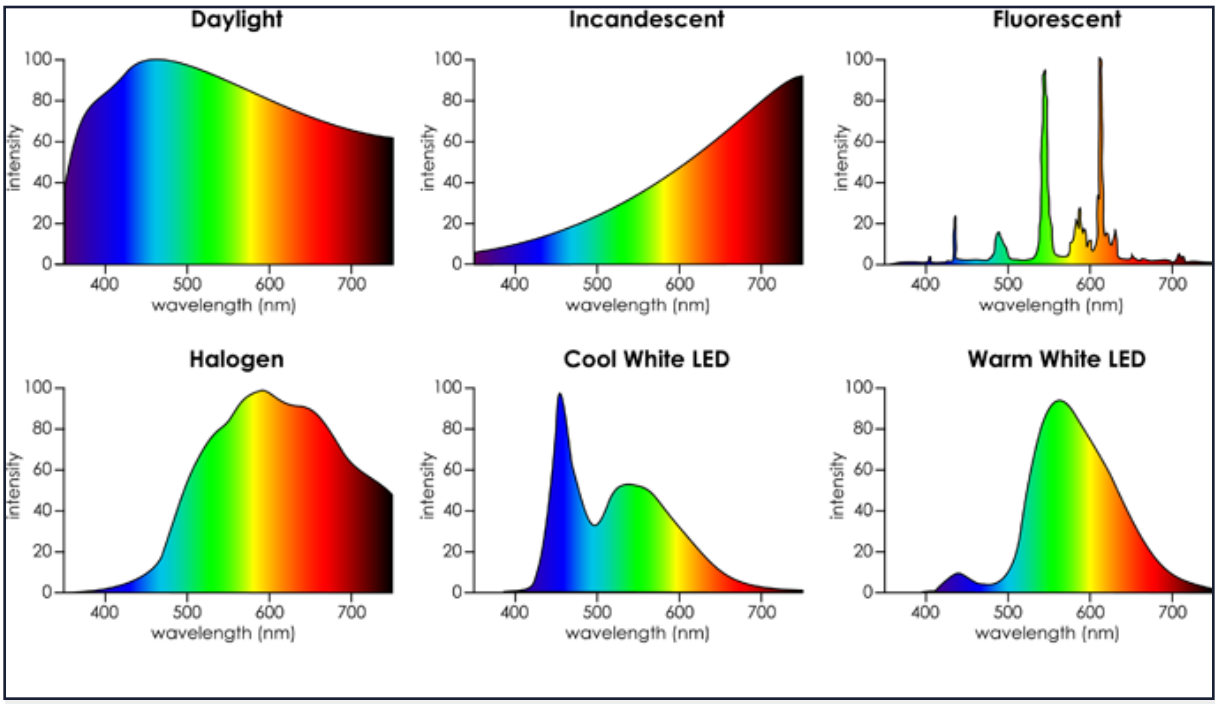

Image Credit: Brewer-Garret

7 Sources of Visible Light

1 Sun

is the Earth's main source of light. The Sun emits radiation right across the electromagnetic spectrum, from extremely high-energy X-rays to ultra-long-wavelength radio waves, and everything in-between. The peak of this emission occurs in the visible portion of the spectrum. [Source]

2 Incandescent Light Bulb

is an electric light with a wire filament heated to such a high temperature that it glows with visible light (incandescence). The output is higher at the red end of the spectrum giving it a warm output. Which also places it mostly outside the visible spectrum. A halogen lamp produces a continuous spectrum of light, from near ultraviolet to deep into the infrared.

3 Fluorescent

short-wave ultraviolet light that causes a phosphor coating on the inside of the lamp to glow. The fluorescent light spectrum has a high intensity at around 480 nm to about 570 nm. Fluorescent lights are mixed with other types of lights to produce a light that is closer to sunlight.

4 Halogen

illumination is produced when a tungsten filament is heated sufficiently to emit light or "incandescence". It uses a halogen gas to increase light output. The halogen spectrum shows there is more intensity at around 650 nm to about 950 nm. This shows that there is more concentration of red light, whose wavelength is about 656.28 nm. [Source]

5 LED

light-emitting diode (LED) is a two-lead semiconductor light source. Emits light when activated. An electrical current passes through a microchip, which illuminates the tiny light sources we call LEDs and the result is visible light. LED devices span the spectrum from ultraviolet (UV), through visible to infrared (IR).

6 Laser

“light amplification by stimulated emission of radiation”. The word laser will be limited to electromagnetic radiation-emitting devices using light amplification by stimulated emission of radiation at wavelengths from 180 nanometers to 1 millimeter. The electromagnetic spectrum includes energy ranging from gamma rays to electricity. [Source]

7 HID (High-intensity discharge)

are a type of electrical gas-discharge lamp which produces light by means of an electric arc between tungsten electrodes housed inside a translucent or transparent fused quartz or fused alumina arc tube. [Source]

Most often seen in large spaces such as stadiums and warehouses. Or in street lights, automotive lights and flood lights.

Conclusion

The light from the sun, UV lamps to sterilize medical devices to night vision technologies are all forms of electromagnetic radiation.

The portion of the electromagnetic spectrum ranging between 400 and 750 nm is the visible region. When we use the term “light”, we refer to the type of electromagnetic wave that can be seen by most humans - the EM wave that stimulates your retina.

When all the wavelengths of the visible light spectrum strike your eye at the same time, white is perceived. White is the combination of all colors of the spectrum.

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