Electromagnetic Spectrum

The following text data may be copied and put into 18 point and given to low vision students as a handout or transposed into a Braille file, embossed, and given as a handout for Braille readers. If you are fortunate enough to have a Talking Tactile Tablet, it lends itself nicely for an audio file for a TTT graphic. The graphics associated with the text make excellent swell form tactile graphics to be used either with the Braille handout or as a TTT overlay.

For a more in depth review of the electromagnetic spectrum and how it is being used in the study of the stars and space, read the book *Touch the Invisible Sky* by Noreen Grice, Simon Steel and Doris Daou, from Ozone Publishing Corporation.

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When most people think of light they think of sunlight or the colors of the rainbow which is visible light. But this is a very small part of the whole spectrum of light which is called the electromagnetic spectrum. This spectrum of different wavelengths goes from the very shortest, known as gamma rays to the longest which are called radio waves.

A wavelength is the distance from the crest or top of one wave, to the crest of the next wave. Look at the figure below the electromagnetic spectrum title on the graphics page. Look at the two vertical lines between the arrows. The distance from one vertical line to the next vertical line is what is called a wavelength or the frequency of the wave. All light travels in waves. The type of light is determined by how many waves pass a point in a given second over a given distance. There are two important properties of waves to keep in mind. As the wavelength gets shorter its frequency increases over a given distance and the amount of energy being carried in the wave increases. That means that gamma rays have the highest energy of all the different types of light and radio waves have the lowest energy.

Now look at the wavy line at the bottom of the graphic. As you observe the wavelengths on this line, remember that it is not to scale. The wavelength of a gamma ray is smaller than an atom and a radio wave can be kilometers long. The different types of light waves found in the electromagnetic spectrum going from the smallest to the largest are: gamma rays, X-rays, ultraviolet rays, visible rays, infrared rays, microwave rays, and radio wave rays.

A gamma ray is light with the most energy. Gamma rays come from exploding stars as well as unstable radioactive elements. X-rays are high-energy waves produced in intense environments such as exploding stars or the accelerated particles from an X-ray machine. Ultraviolet rays are waves that still have a lot of energy. They are emitted from extremely hot objects. These are the rays that give you a sunburn when you stay out in the sunshine too long. Visible rays are the light that we can see with our eyes. Infrared rays are sometimes thought as heat waves but in reality they are on the lower energy side of the electromagnetic spectrum. Microware rays are sometimes called high energy radio waves. Radio waves have the lowest amount of energy due to their extremely long wavelengths. These waves are produced when electrons twist around magnetic fields.

As you notice, all of the different rays have a region that they exist in, not just one little point. That means that there are different types of gamma rays, different types of X-rays, different types of visible light rays, etc. You are familiar with the general types of light rays in the form of rainbow colors. Each color is a different wave length and each of these colors has different wavelengths that give us the diverse shades of each color. Thus, visible light has a frequency range from 400 nanometers (nm) to around 700 nm. This is a very narrow portion of the spectrum compared to the other light ranges. Most of the light from the Sun is in the visible light range.

Everything in the universe gives off light in one form or another. What the object is made off, its temperature, and its magnetic fields determine what type of light will be emitted. For example, microwaves found in space are given off by giant molecular clouds with temperatures as low as 73 K which is a minus 200 degrees Celsius or a negative 392 degrees Fahrenheit. Stars that are not very bright in the visible light may shine very brightly in infrared, ultraviolet, or X-ray light. All these light sources however, are invisible to the human eye and we need instruments to detect them.

As stated, every object, every element, every atom, everything emits light that is unique to that object. This is referred to as the spectral signature of that element or compound. Knowing this then, by making a spectral analysis, or analyzing the light given off by objects or stars, we can tell what they are made of and what the temperatures of the objects are.

G = gamma ray

X = x-ray

U = ultraviolet

V = visible

I = infrared

M = microwave

R = radio

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