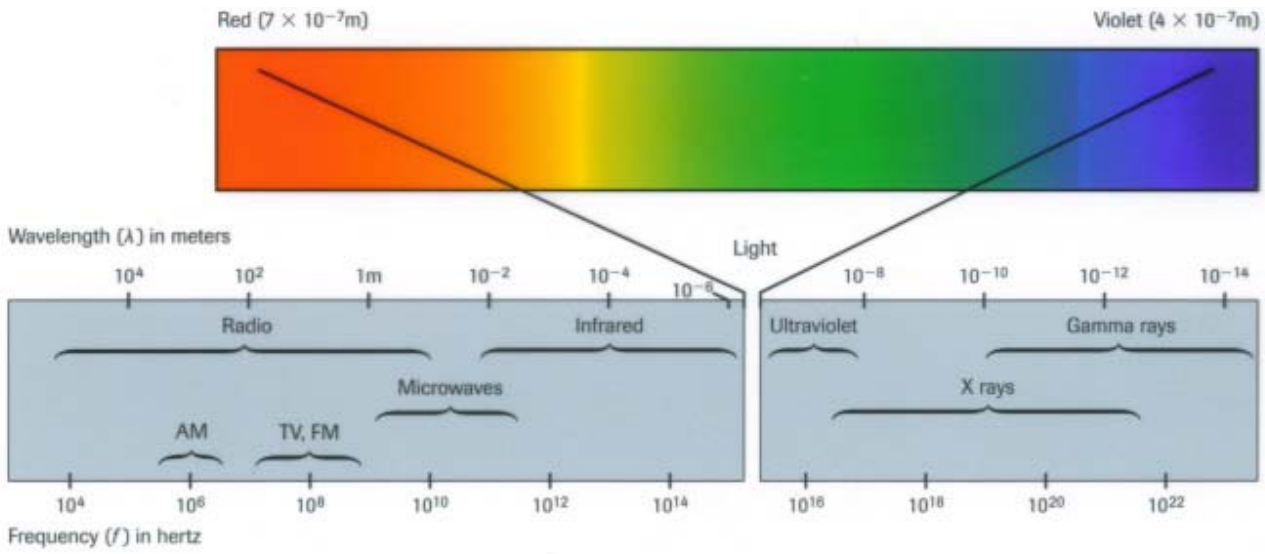
Name _____ Date _____ Period _____

Lab: The Electromagnetic Spectrum

CHAPTER 27: LIGHT

Background: The electromagnetic spectrum is a continuum of all electromagnetic waves arranged according to frequency and wavelength. The sun, earth, and other bodies radiate electromagnetic energy of varying wavelengths. Electromagnetic energy passes through space at the speed of light in the form of sinusoidal waves. The wavelength is the distance from wave crest to wave crest (see figure below).

Light is a particular type of electromagnetic radiation that can be seen and sensed by the human eye, but this energy exists at a wide range of wavelengths. The micron is the basic unit for measuring the wavelength of electromagnetic waves. The spectrum of waves is divided into sections based on wavelength. The shortest waves are gamma rays, which have wavelengths of 10e-6 microns or less. The longest waves are radio waves, which have wavelengths of many kilometers. The range of visible consists of the narrow portion of the spectrum, from 0.4 microns (blue) to 0.7 microns (red).



In science each area of study (astronomy, high-energy physics, etc) has its own jargon and favored system of units for the electromagnetic spectrum. This applet is intended to show the relationship between these units when talking about electromagnetic (EM) radiation. It will also help the student become familiar with these units and the different spectral regions. Also, it can serve as a quick unit converter.

Procedure:

1. Log onto the following website: http://lectureonline.cl.msu.edu/~mmp/applist/Spectrum/s.htm
2. Follow the steps below and answer the questions as you get to them before you move on.

Part 1: Component Parts of the Electromagnetic Spectrum

- What are the seven listed types of electromagnetic radiation (EM radiation) illustrated in this applet? List them from left to right.

In this applet, you can click on the ***wavelength/frequency*** scale and change the ***wavelength*** and ***frequency*** by dragging the mouse around.

Note the appearance of a blue vertical line or position bar to indicate your position along the electromagnetic spectrum. The values of ***frequency***, ***wavelength***, and ***energy*** (with selected units) correspond to the location of the "white position bar".

Part 2: Wavelength range for Electromagnetic Waves

- Click on the EM scale to move the "blue position bar". What is the unit of wavelength used in the applet program?

Wavelength Units: A nanometer is a small unit of length equal to 1×10^{-9} meters

- Locate the vertical blue line and state what type of wave has a one meter wavelength (x10o = 1.0):

- Locate the following wavelengths and indicate the type of electromagnetic radiation associated with these wavelengths. Convert the wavelengths to meters.

Wavelength in nanometer => Scientific Notation	Type of Electromagnetic Radiation
10,000,000,000 nanometers = **1.0×10^{1} meters**	
10,000,000 nanometers = _____meters	
10,000 nanometers = _____meters	
600 nanometers = _____meters	
27 nanometers = _____meters	
1 nanometer = _____meters	
0.01 nanometer = _____meters	

- Which electromagnetic wave type has the largest wavelength?

- Which electromagnetic wave type has the smallest wavelength?

- Which has the largest wavelength?

    - Radio waves or x-rays? _____
    - Infrared or Visible light (V)? _____
    - Microwaves or Ultraviolet (UV) _____
    - Gamma or x-rays? _____

- Would you agree that the simulation has the Electromagnetic waves organized by wavelengths?

- Would you agree that longer wavelengths are found at the gamma ray end of the spectrum?

Use the Electromagnetic Wave simulation and determine the how many times greater the average radio wave wavelength is to the average gamma ray wavelength. (Assume by clicking in the middle of the wave names on the chart that the average value will be given. For example, the average microwave wavelength would be 0.01 meters.)

- Average Radio wave Wavelength = _____ meters
- Average Gamma Ray Wavelength = _____ meters
- Radio Wave wavelengths are _____ times greater than gamma ray wavelengths.

Part 3: Frequency and Electromagnetic Waves

- Click on the EM scale and notice the frequency units. What are the two unit choices for frequency? List them below:

- ***Frequency Units***

AM radio stations broadcast at a frequency of kilohertz and FM radio broadcast at a frequency of megahertz?

My favorite AM station is KMOX, St. Louis. The frequency of the station is 1140 kilohertz with a wavelength of _____meters.

My favorite FM station is KEZK, St. Louis. The frequency of the station is 102.5 megahertz with a wavelength of _____ meters.

Which radio station has the longest wavelength? _____ (AM or FM)

Are they both radio waves according to the Electromagnetic Spectrum simulation? _____

Click and drag the white vertical position marker across the Electromagnetic spectrum simulation and determine where the large frequency waves are located. Which end of the Electromagnetic spectrum has the largest frequencies? _____. Is this the same end that has the largest wavelengths? _____. Does the electromagnetic spectrum seem to be organized or arranged based on frequency and wavelength? _____

Click near the visible spectrum (V) on the chart until the spectrum of colors appear. Which color has the largest wavelength? _____ Largest frequency? _____.

Part 4: Energy and Electromagnetic Waves

- What are the two units of energy used in the Electromagnetic Wave Simulation?

- Arrange the energy units from largest to smallest in value?

Largest = _____

Smallest = _____

- Click and drag the white vertical position line across the electromagnetic spectrum simulation and determine where the most energetic waves are to be found. Which type of wave has the most energy?

- Which has the least energy? _____ Which visible color has the most energy?

- Which color has the least amount of energy?

- What type of wave is it? From the following clues determine the wave type and circle one item that relates to what this person is doing or being exposed to?

Wave Fact/Data	Wave Type	Person's Activity (Select one for each row)
10 angstrom wavelength		(Dental Exam) (Reading) (Listening to radio) (Tanning) (Cooking)
32 GHz frequency		(Dental Exam) (Reading) (Listening to radio) (Tanning) (Cooking)
10.8 meters wavelength		(Dental Exam) (Reading) (Listening to radio) (Tanning) (Cooking)
6.28E-18 joules of energy		(Dental Exam) (Reading) (Listening to radio) (Tanning) (Cooking)
23,808 GHz frequency		(Dental Exam) (Reading) (Listening to radio) (Tanning) (Cooking)

Using a reference source or text to complete the following:

1. When an _____ is accelerated, EM radiation is released.
2. This radiation can be interpreted as either _____-like (an oscillating disturbance in the EM field) - or _____ like (a massless particle called the _____) moving outward at the speed of _____.
3. The more energetic the photon, the _____ it's wavelength or the _____ its frequency.