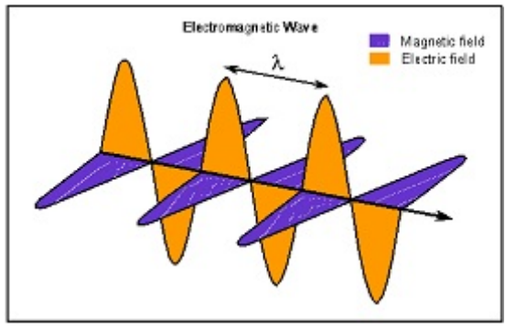
PHYSICS 2204
UNIT 4:WAVES
Worksheet #9: Introduction To Electromagnetic Waves

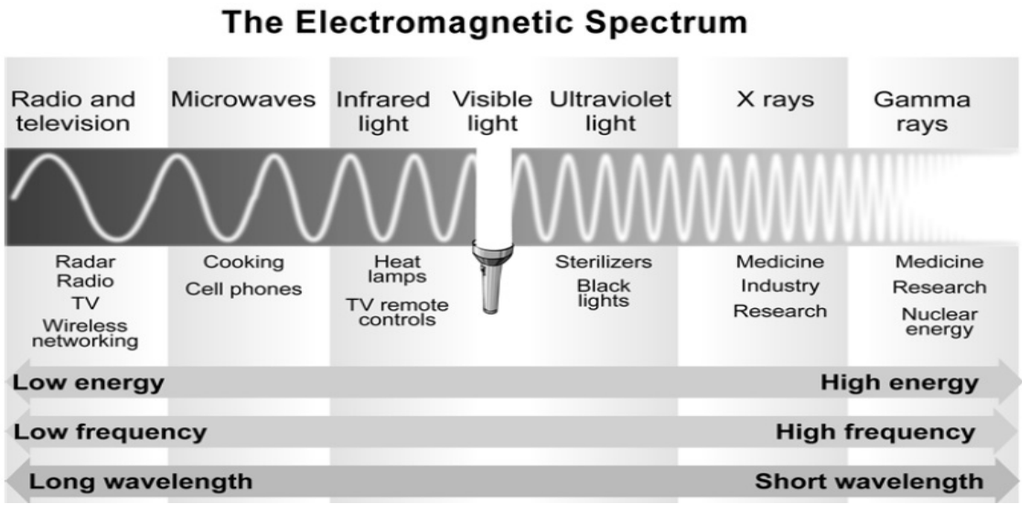
Student Name: _____

Radiation : is the emission of energy as electromagnetic (EM) waves that comes from a source and travels through space and may be able to penetrate various materials.

Electromagnetic wave is a transverse wave that has both electric and magnetic properties, hence the name. It is assumed that the electric part is vibrating at right angles to the magnetic part

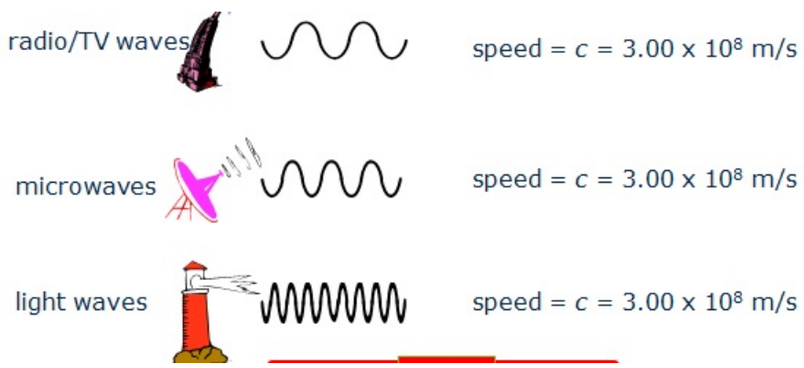


Electromagnetic Spectrum consists of all the different wavelengths of electromagnetic radiation, including visible light, radio waves, and X-rays.



Albert Michelson was the first person to precisely measure the speed of light ($c = 3.0 \times 10^8$ m/s)

All electromagnetic waves move at the speed of light as shown below:

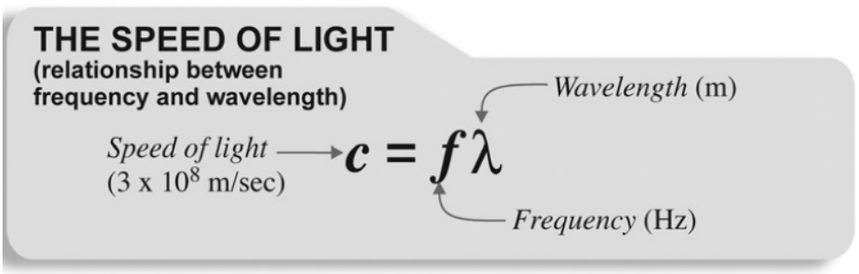


The Universal Wave Equation and Electromagnetic Waves:

Remember the speed of a wave is found using the universal wave equation:

$$v = f\lambda$$

For Electromagnetic Radiation (EM) v =c, therefore, the formula becomes:



Remember the metric Prefixes:

Prefix	Symbol		Multiplier
exa	E	10^{18}	1,000,000,000,000,000,000
peta	P	10^{15}	1,000,000,000,000,000
tera	T	10^{12}	1,000,000,000,000
giga	G	10^{9}	1,000,000,000
mega	M	10^{6}	1,000,000
kilo	k	10^{3}	1,000
hecto	h	10^{2}	100
deka	da	10^{1}	10
deci	d	10^{-1}	0.1
centi	c	10^{-2}	0.01
milli	m	10^{-3}	0.001
micro	μ	10^{-6}	0.000,001
nano	n	10^{-9}	0.000,000,001
pico micro micro	p $\mu\mu$	10^{-12}	0.000,000,000,001
femto	f	10^{-15}	0.000,000,000,000,001
atto	a	10^{-18}	0.000,000,000,000,000,001

Example 1:

The waves used by a microwave oven to cook food have a frequency of 2.45 gigahertz (2.45×10^9 Hz). Calculate the wavelength of this type of wave.

Example 2:

Other than the Sun, the nearest star to earth is Alpha Centauri which is 4 light years away. How far is that in km?

Visible light refers to the range of wavelengths on the electromagnetic spectrum that are visible to the naked human eye. It is a source of energy that is visible to the eye.

In what ways can light be produced?

1)Incandescent sources emit light because they are at high temperatures. (Examples, Sun, fires, light bulb…)

2)Fluorescent sources: refers to gasses that emit light when they are struck by high energy waves or particles.

3)Phosphorescent source: becomes luminous when struck by high energy waves or particles, and remain luminous for awhile.

4)Chemiluminescent : is the emission of light as the result of a chemical reaction. There is no significant change in temperature

5)bioluminescent : organisms that can emit energy because of chemical reactions (fish, firflies..etc)

PART A: MULTIPLE CHOICE

Instructions: Instructions: Shade the letter of the correct answer on the computer scorable answer sheet provided.

1. Which of the following consist of a wave that consists of two perpendicular transverse waves with one component of the wave being a vibrating electric field and the other being a corresponding magnetic field?

   (A) Induction wave
   (B) Electromagnetic wave
   (C) Radiant wave
   (D) Sound wave

2. What is the same for all electromagnetic waves travel through a vacuum?

   (A) Same speed
   (B) Same wavelenght
   (C) Speeds that are proportional to their frequency
   (D) Speeds that are inversely proportional to their frequency

3. How do Electromagnetic waves travel?

   (A) Longitudinal
   (B) Transverse
   (C) Both longitudinal and transverse
   (D) None of the above

4. Which of the following precisely determine the speed of light?

   (A) Albert Michelson
   (B) Albert Einstein
   (C) Albert Fifield
   (D) Isaac Newton

5. What letter is used to represent the speed of light?

(A) a
(B) c
(C) s
(D) v

6. What speed does all electromagnetic waves travel at**?**

(A) 3.0 m/s
(B) 362 m/s
(C) 3.0×10^{8} m/s
(D) 3.6×10^{8} m/s

7. Which of the following is true about the frequency and velocity of electromagnetic waves?

(A) As frequency increases, wavelength decreases
(B) As frequency increases, wavelength increases
(C) Frequency is constant for all wavelengths
(D) Frequency and wavelength are independent of each other

8. Which of the following are electromagnetic waves?

(A) Radio waves
(B) Optical light
(C) X-rays
(D) All of these

9. Compared with light waves, which is true for radio waves?

(A) Have higher energy
(B) Are higher frequency
(C) Are not composed of photons
(D) Have longer wavelengths

10. What distance will a radio wave will travel in 0.250 s?

(A) 7.50×10^{7} m
(B) 5.60×10^{7} m
(C) 1.20×10^{9} m
(D) 1.35×10^{9} m

11. What is the wavelength of an electromagnetic wave with a frequency of 5.00×10^{14} Hz?

(A) 5.64×10^{-7} m
(B) 1.5×10^{-6} m
(C) 6.00×10^{-7} m
(D) 3.00×10^{-8} m

12. What is the frequency of an electromagnetic wave with a wavelength 2.75×10^{-8} m?

(A) 1.10 Hz
(B) 1.09×10^{16} Hz
(C) 9.17×10^{15} Hz
(D) 9.17×10^{16} Hz

13. What is the wavelength of light waves if their frequency is 5.0×10^{14} Hz?

(A) 0.60 m
(B) 6.0 mm
(C) 0.060 mm
(D) 0.60μm

14. How long does it take light to travel 1.0 m?

(A) 3.3 ns
(B) 3.3 μs
(C) 3.3 ms
(D) 3.3 s

15. What is the wavelength of a 92.9 MHz radio wave?

(A) 32 mm
(B) 32 cm
(C) 3.2 m
(D) 32 m

16. What frequency are 20 mm microwaves?

(A) 100 MHz
(B) 400 MHz
(C) 15 GHz
(D) 73 GHz

PART B: WRITTEN RESPONSE

1. Yellow light has a longer wavelength than green light. Which color of light has the higher frequency?

2. Green light has a lower frequency than blue light. Which color of light has a longer wavelength?

3. Calculate the wavelength of violet light with a frequency of 750×10^{12} Hz.

4. Calculate the frequency of yellow light with a wavelength of 580×10^{-9} m.

5. Calculate the wavelength of red light with a frequency of 460×10^{12} Hz.

6. Calculate the frequency of green light with a wavelength of 530×10^{-9} m.

7. The waves used by a microwave oven to cook food have a frequency of 2.45 gigahertz (2.45×10^9 Hz). Calculate the wavelength of this type of wave.

8. A radio station has a frequency of 90.9 megahertz (9.09 × 107 Hz). What is the wavelength of the radio waves the station emits from its radio tower?

9. An x-ray has a wavelength of 5 nanometers (5.0 × 10-9 m). What is the frequency of x-rays?

10. The ultraviolet rays that cause sunburn are called UV-B rays. They have a wavelength of approximately 300 nanometers (3.0×10^{-7} m). What is the frequency of a UV-B ray?

11. Infrared waves from the sun are what make our skin feel warm on a sunny day. If an infrared wave has a frequency of 3.0×10^{12} Hz, what is its wavelength?

12. Electromagnetic waves with the highest amount of energy are called gamma rays. Gamma rays have wavelengths of less than 10-trillionths of a meter (1.0×10^{-11} m).

    a. Determine the frequency that corresponds with this wavelength.

    b. Is this the minimum or maximum frequency of a gamma ray?

14. Use the information from this sheet to order the following types of waves from lowest to highest frequency: visible light, gamma rays, x-rays, infrared waves, ultraviolet rays, microwaves, and radio waves.

15. Use the information from this sheet to order the following types of waves from shortest to longest wavelength: visible light, gamma rays, x-rays, infrared waves, ultraviolet rays, microwaves, and radio waves.