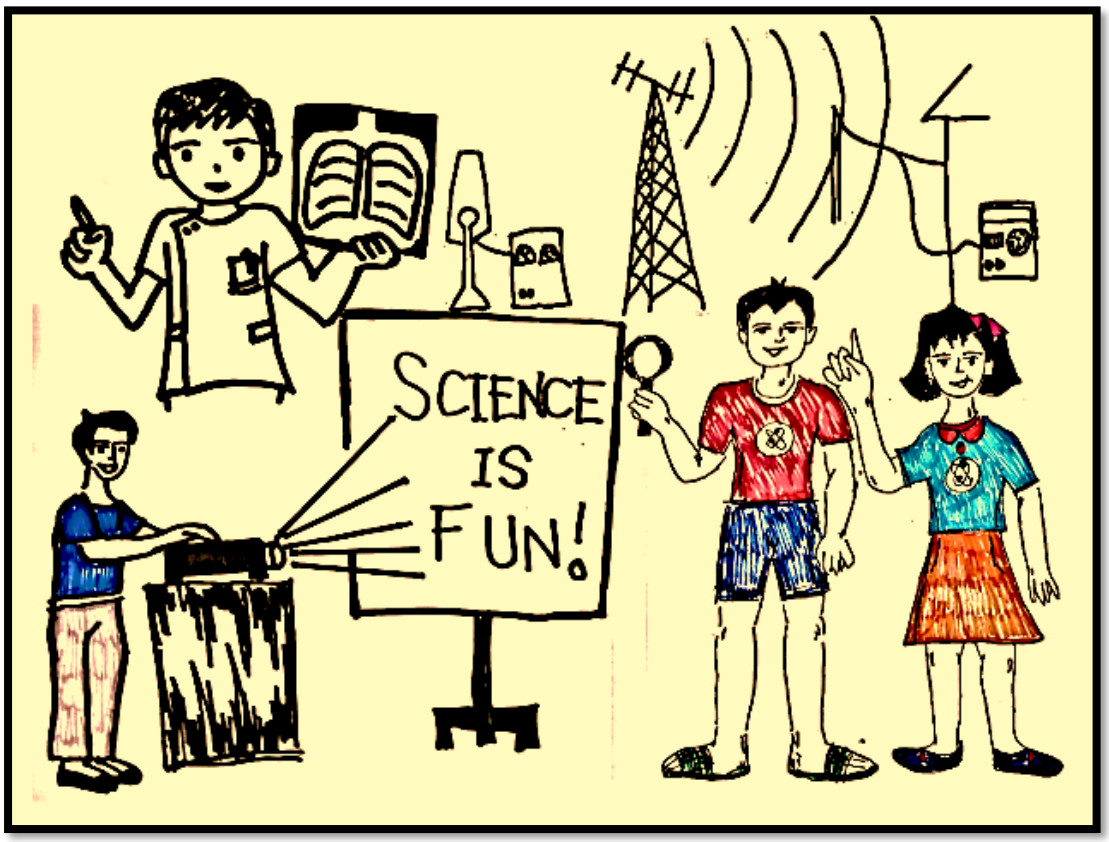
SELF- LEARNING KIT IN SCIENCE 10

ELECTROMAGNETIC SPECTRUM



MARIO JAMES S. DELA CRUZ
Santiago City National High School

SCIENCE 10
Self- Learning Kit
Quarter 2 Module 3: ELECTROMAGNETIC SPECTRUM
First Edition, 2024

Department of Education
Secretary: **SARA Z. DUTERTE**

Development Team

Writer: **MARIO JAMES S. DELA CRUZ**, Master Teacher I

Reviewers: **CLARISSA F. SOLIVEN-** EPS- Science; **PERFECTA M. BAUSTISTA PhD**- EPS-English;
MARIVEL G. MORALES- EPS- LRMDS; **JENELYN B. BUTAC**- Division Librarian;
JAY LORD B. GALLARDE- PDO II

Illustrator/ Layout Artist: **MARIO JAMES S. DELA CRUZ**, Master Teacher I

Management Team: **CLARISSA F. SOLIVEN**, EPS- Science; **JANETTE V. BAUTISTA EdD**, CID- Chief;
JACQUELINE S. RAMOS PhD, CESE, OIC-Assistant Schools Division Superintendent;
FLORDELIZA C. GECOBE PhD, CESO V, Schools Division Superintendent

Printed in the Philippines
Department of Education-Region II
Schools Division of Santiago City
Telephone Nos.: (078) 682-0151; (078) 682-0156
Email Address: santiago.city@deped.gov.ph

FOREWORD

This Self-Learning Kit aims to guide Grade 10 students on familiarizing the different regions of electromagnetic wave and identifying the relative wavelength, frequency, and energy of each of the different types of electromagnetic waves.

Everyday life is pervaded by artificially made electromagnetic radiation: food is heated in microwave ovens, airplanes are guided by radar waves, television sets receive electromagnetic waves transmitted by broadcasting stations, and infrared waves from heaters provide warmth. Infrared waves also are given off and received by automatic self-focusing cameras that electronically measure and set the correct distance to the object to be photographed. As soon as the Sun sets, incandescent or fluorescent lights are turned on to provide artificial illumination, and cities glow brightly with the colorful fluorescent and neon lamps of advertisement signs.

The different activities in this kit will enable students to explore the different regions of the electromagnetic spectrum. The activities provide students analytical thinking while doing their given tasks.

SCIENCE 10
PIONEERS OF ELECTROMAGNETIC THEORY

CONTENT STANDARD

The learners demonstrate an understanding of the different regions of the electromagnetic spectrum.

PERFORMANCE STANDARD

The learners should be able to perform differentiated activities on electromagnetic waves.

MOST ESSENTIAL LEARNING COMPETENCY

Cite examples of practical applications of the different regions of EM waves, such as the use of radio waves in telecommunications
Code: (S10FE-IIa-b-48)

SPECIFIC OBJECTIVES

1. Familiarize the different regions of electromagnetic wave.

2. Identify the relative wavelength, frequency, and energy of each of the different types of electromagnetic waves.

WHAT HAPPENED?

JUMBLED WAVE CONCEPTS

DIRECTIONS: You have learned about waves during your Science 7 class. Let's recall some important terms about waves.

Below are descriptions of different terms relating to waves and the jumbled letters which will form the correct term. Your task is to rearrange the jumbled letters to form the term being described. Write your answer on the given blank box.

1	It is a disturbance in space.	**A V W E**	
2	It is the highest point in a wave.	**S E C R T**	
3	It is the lowest point in a wave.	**T G H U R O**	
4	It is the distance from the midpoint to the highest (or lowest) point of a wave.	**L M U P T D E A I**	
5	It is the distance between successive identical parts of a wave.	**E N E V T G W L A H**	
6	It refers to the number of waves produced in one second.	**N E Q F C E U R Y**	
7	It refers to the extent or the limits between which variation is possible.	**A R G N E**	

**Adopted:*
Alternative Delivery Mode
Quarter 2 – Module 1: Different Forms of EM Waves pp. 5

PRE- TEST

DIRECTIONS: Write the letter of your answer on the space before the number.

_____1.Which of the following statements is CORRECT?
a. Gamma ray has the highest frequency and the highest energy.
b. Gamma ray has the highest frequency but has the least energy.
c. Radio wave has the highest frequency and the highest energy.
d. Radio wave has the lowest frequency but has the highest energy.

_____2. Which among the following EM waves has the longest wavelength?
a. infrared b. radio wave c. visible light d. x-ray

_____3. Which among the following EM waves has the HIGHEST frequency among others?
a. infrared b. ultraviolet c. microwave d. x-ray

_____4. Which of the following EM waves has the LEAST amount of energy?
a. gamma ray b. radio wave c. microwave d. x-ray

_____5. The wavelength of microwaves ranges from $1x10^{-1}$ m to $1x10^{-3}$ m. Which of the following has size comparable to the wavelength of microwave?
a. Bacteria b. Coin c. Human d. Pin

_____6. What is the frequency range of infrared radiation?
a. 3×10^{9} Hz – 3×10^{11} Hz
b. 3×10^{11} Hz – 4×10^{14} Hz
c. 3×10^{14} Hz – 3×10^{15} Hz
d. 3×10^{16} Hz – 3×10^{19} Hz

_____7. Which electromagnetic wave can travel the farthest distances because it has a wavelength range of greater than $1x10^{-1}$ m?
a. gamma ray b. microwave c. radio wave d. x-ray

_____8. Which two colors of light lie at the beginning and end of the visible spectrum?
a. red and violet
b. red and yellow
c. yellow and violet
d. yellow and green

_____9. This type of EM wave has a wavelength similar to the size of PBA basketball court (28 meters).
a. microwave b. radio wave c. ultraviolet d. visible light

_____10. Which of the following electromagnetic waves has the LEAST wavelength range?
a. infrared b. ultraviolet c. visible light d. x-ray

WHAT TO LEARN?

WHAT IS ELECTROMAGNETIC WAVE?
A Reading Comprehension

Electromagnetic waves are different from mechanical waves in some important ways. Electromagnetic waves are disturbance that transfers energy through a field. They are also referred to as EM waves. They can travel through medium but what makes them strange is that they can also transmit through empty space.

Radiation is a term used to describe the transfer of energy in the form of EM wave. For a mechanical wave to travel, it must vibrate the medium (solid, liquid, gas and plasma) as it moves. This makes use some of the waves' energy. In the end, it makes them transfer all energy in the medium. As for EM waves, they can travel through empty space or vacuum, so they do not give up their energy. This enables EM waves to cross great distances such as that from the sun to the earth (which is almost a vacuum) without losing much energy. In vacuum, EM waves travel at a constant speed of 300,000,000 m/s. At this rate, the rays of the sun take 8 minutes to reach the earth.

Electromagnetic waves can also transmit with a material medium. They can also transfer energy to the medium itself. When they interact with matter, their energy can be converted into many different forms of energy. With these characteristics, electromagnetic waves are used for a wide variety of purposes.

Q AND A PORTION

Answer the following questions. Write your answers on the space provided.

1. Why does EM waves different from mechanical waves?

2. Which one characteristic of EM wave can support that a ray from the sun can take 8 minutes only to reach the earth?

3. Are all EM waves have radiation? Why?

4. How do EM waves transmit their energies?

THE ELECTROMAGNETIC SPECTRUM

Electromagnetic spectrum is the entire distribution of electromagnetic radiation according to frequency or wavelength. Although all electromagnetic waves travel at the speed of light in a vacuum, they do so at a wide range of frequencies, wavelengths, and photon energies.

The electromagnetic spectrum comprises the span of all electromagnetic radiation and consists of many subranges, commonly referred to as portions, such as visible light or ultraviolet radiation.

The various portions bear different names based on differences in behavior in the emission, transmission, and absorption of the corresponding waves and also based on their different practical applications.

The different types of electromagnetic waves are defined by the amount of energy carried by/ possessed by the photons. Photons are bundles of wave energy. The energy of photon E is given by the equation:

$$E = hf$$

where h is the Planck's Constant and f is the frequency of the EM wave. The value of the Planck's Constant is 6.63×10^{-34} joules per second (J/s).

From among the EM waves, the gamma rays have photons of high energies while radio waves have photons with the lowest energies. With regards to wavelength, radio waves can be likened to the size of a football field while gamma rays are as small as the nuclei of an atom. Radio waves have the longest wavelength, and gamma rays have the shortest wavelength.

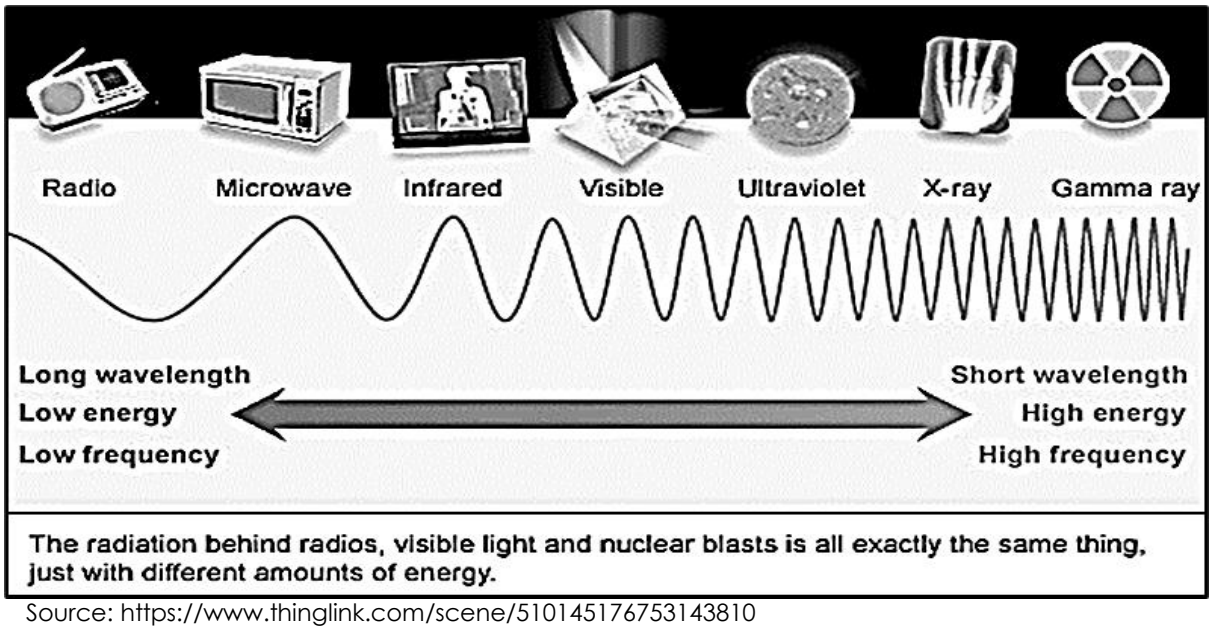
The electromagnetic spectrum is a continuum of electromagnetic waves arranged according to frequency and wavelength. It is a gradual progression from the waves of lowest frequencies to the waves of highest frequencies.

According to increasing frequency, the EM spectrum includes: radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays.

Q AND A PORTION

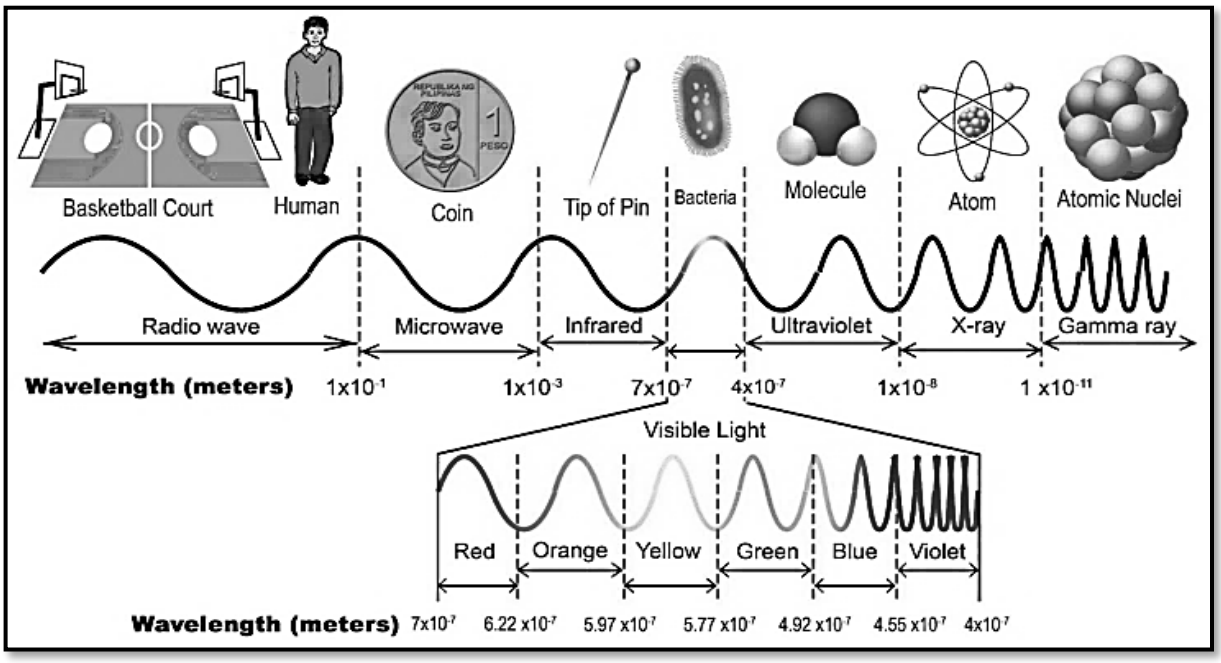
5. What defines the types of EM waves from one another?
6. How will you characterize an electromagnetic spectrum?
7. How will you describe a photon?
8. What are the different regions of electromagnetic spectrum?
9. How will you differentiate electromagnetic waves from electromagnetic spectrum?

Figure 1: The Electromagnetic Spectrum



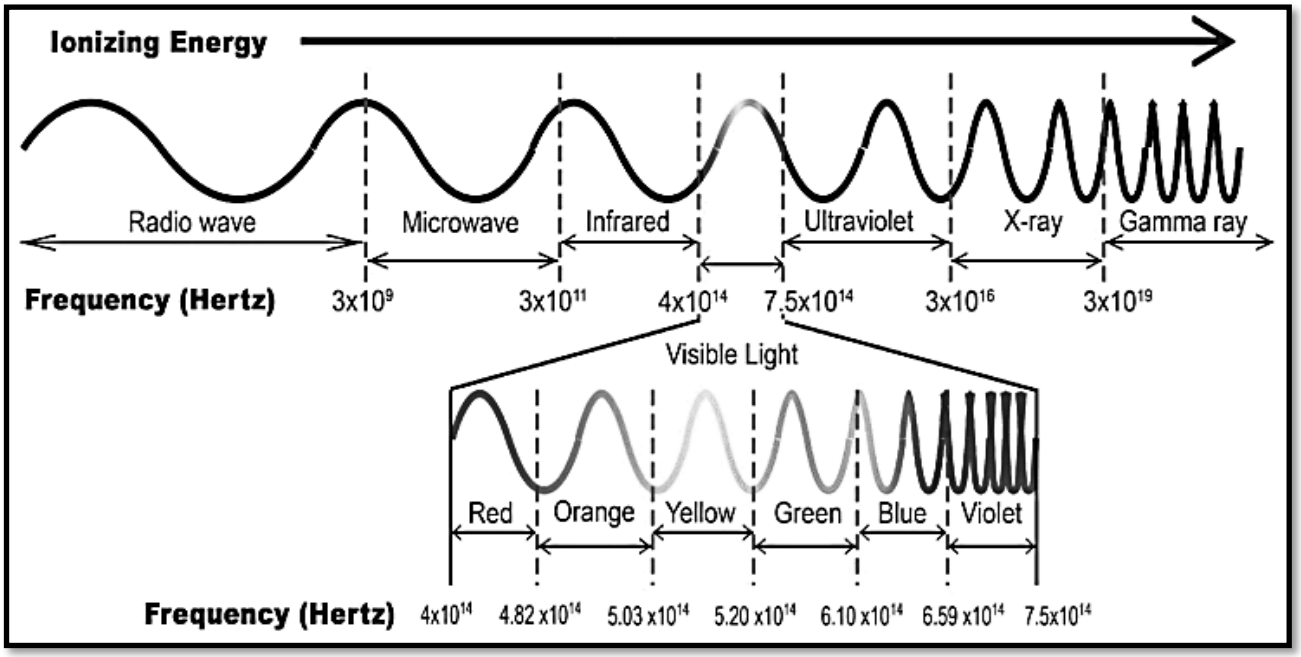
Source: https://www.thinglink.com/scene/510145176753143810

Figure 2: EM Spectrum Wavelength



Illustrator: Louella C. Zacarias, adopted with modifications from https://www.nasa.gov/directorates/heo/scan/spectrum/overview/index.html

Figure 3: EM Spectrum Frequency



Illustrator: Louella C. Zacarias, adopted with modifications from
https://www.nasa.gov/directorates/heo/scan/spectrum/overview/index.html

WHAT HAVE YOU LEARNED?

ACTIVITY 1
COMPLETE MY EM WAVE IDEAS

LESS THAN	THE SAME AS	GREATER THAN

DIRECTIONS: Use one of the three phrases above to complete each sentence. Each phrase may be used once, more than or not at all. Write your answer on the space provided.

_____1. The wavelength of radio waves is _____ the wavelength of ultraviolet radiation.

_____2. In a vacuum, the speed of ultraviolet radiation is _____ the speed of light or visible light.

_____3. The frequency of infrared radiation is _____ the frequency of gamma rays.

_____4. The energy of x-ray is _____ the energy of microwave radiation.

_____5. The wavelength of gamma radiation is _____ the wavelength of infrared radiation.

_____6. The frequency of an infrared is _____ the frequency of an ultraviolet ray.

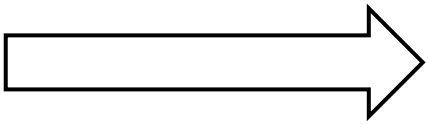
_____7. The speed of waves in all the regions of the EM Spectrum is _____.

ACTIVITY 2
ARRANGE MY JUMBLED EM WAVE TERMS

DIRECTIONS: Arrange the jumbled letters below to form an idea related to Electromagnetic Wave. Write your answers on the given arrows.

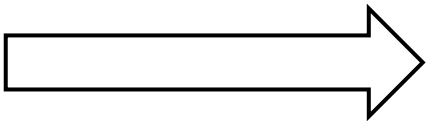
1. Electromagnetic _____ - other name of electromagnetic wave.

N	A	I	D	T	R	O	I	A



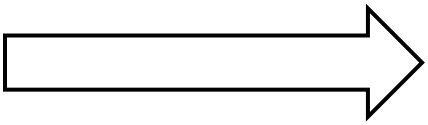
2. Type of wave that needs a medium in order to propagate or generate.

E	L	A	C	C	H	I	A	M	N



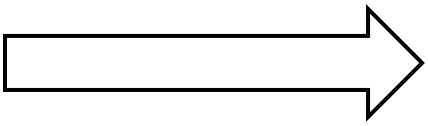
3. A region with empty space, example is our outer space.

A	U	V	U	C	M



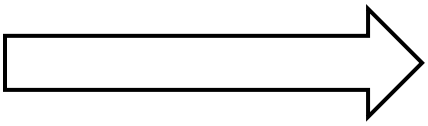
4. Electromagnetic _____ - continuum of EM wave arranged according to frequency and wavelength.

M	S	U	P	R	C	E	T



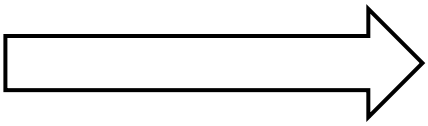
5. They are bundles of wave energy.

O	N	H	P	O	T



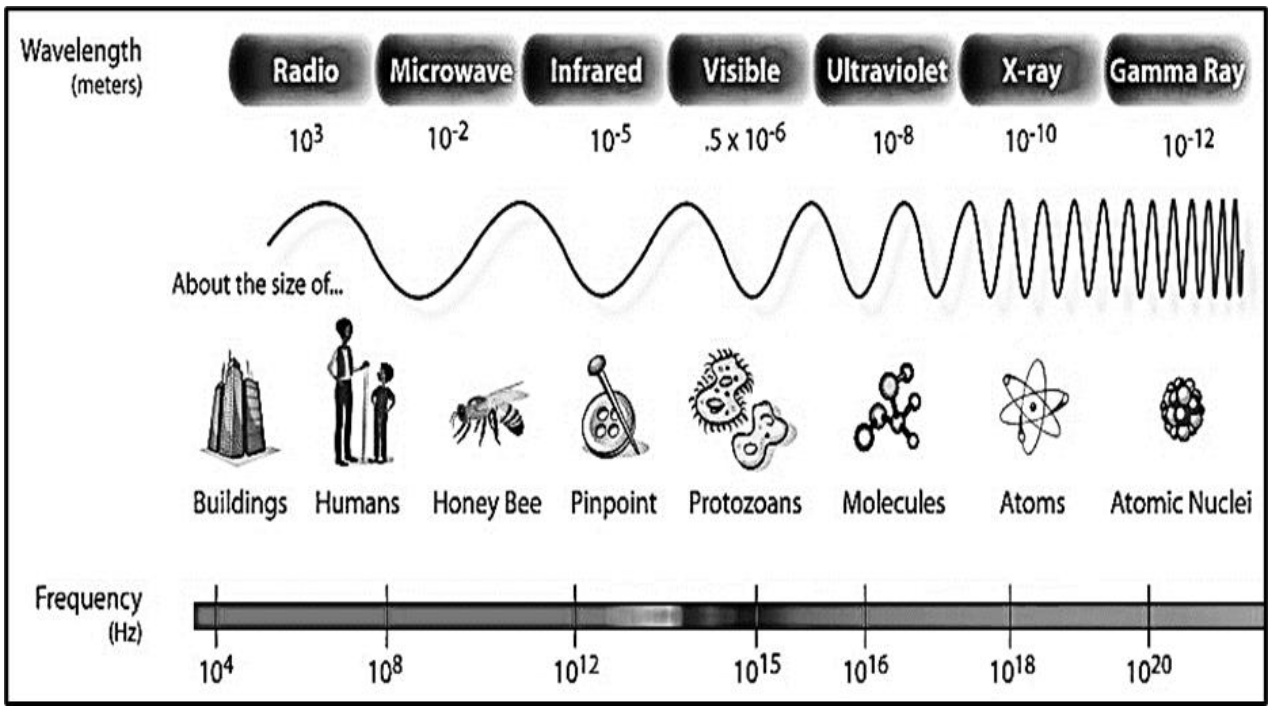
6. The radiation behind radio waves, visible light and nuclear explosions is exactly the same. In what amount do they differ?

N	E	G	R	Y	E



ACTIVITY 3
MATCH ME WITH MY EM WAVE DESCRIPTION

DIRECTIONS: Refer to the Electromagnetic Spectrum Chart below. Identify the different regions that match to the given description in each number. Write your answer on the space provided.



https://www.pinterest.ru/pin/411446115936458446/visualsearch/?cropSource=6&h=379&w=530&x=24&y=11

	MY ANSWER	DESCRIPTION
1		It has the greatest frequency in the spectrum.
2		Its size ranges from the size of a human and a honeybee.
3		The wavelength is approximately 0.5 x 10^{-6} m.
4		It has the largest wavelength in the spectrum.
5		Its size ranges between protozoans and molecules.
6		The frequency of this region is known to be 10^{18} Hz.
7		Its frequency lies between 10^{-2} and 0.5 x 10^{-6} m.

POST- TEST

DIRECTIONS: Write the letter of your answer on the space before the number.

_____1. Which electromagnetic wave can travel the farthest distances because it has a wavelength range of greater than $1x10^{-1}$ m?
a. gamma ray b. microwave c. radio wave d. x-ray

_____2. Which of the following EM waves has the LEAST amount of energy?
a. gamma ray b. radio wave c. microwave d. x-ray

_____3. Which among the following EM waves has the longest wavelength?
a. infrared b. ultraviolet c. radio wave d. x-ray

_____4. The wavelength of microwaves ranges from $1x10^{-1}$ m to $1x10^{-3}$ m. Which of the following has size comparable to the wavelength of microwave?
a. Bacteria b. Coin c. Human d. Pin

_____5. Which among the following EM waves has the HIGHEST frequency among others?
a. infrared b. ultraviolet c. microwave d. x-ray

_____6. What is the frequency range of infrared radiation?
a. 3×10^{9} Hz – 3×10^{11} Hz
b. 3×10^{11} Hz – 4×10^{14} Hz
c. 3×10^{14} Hz – 3×10^{15} Hz
d. 3×10^{16} Hz – 3×10^{19} Hz

_____7. Which of the following statements is CORRECT?
a. Gamma ray has the highest frequency and the highest energy.
b. Gamma ray has the highest frequency but has the least energy.
c. Radio wave has the highest frequency and the highest energy.
d. Radio wave has the lowest frequency but has the highest energy.

_____8. Which two colors of light lie at the beginning and end of the visible spectrum?
a. red and violet
b. red and yellow
c. yellow and violet
d. yellow and green

_____9. This type of EM wave has a wavelength similar to the size of PBA basketball court (28 meters).
a. microwave b. radio wave c. ultraviolet d. visible light

_____10. Which of the following electromagnetic waves has the LEAST wavelength range?
a. infrared b. ultraviolet c. visible light d. x-ray

REFERENCES

Printed Sources

Alternative Delivery Mode Quarter 2 – Module 1: Different Forms of EM Waves pp. 5

Stephen Pople. 2007. *Complete Physics for IGCSE.* London: Oxford University Press.

Internet Sources

Carrington. “PPT - Frequency Low Wavelength Long Energy Low PowerPoint Presentation - ID:5152338.” SlideServe, October 4, 2014. https://www.slideserve.com/carrington/frequency-low-wavelength-long-energy-low.

“Media Is Not Available Right Now - ThingLink,” n.d. https://www.thinglink.com/scene/510145176753143810.

Phillips, Melba, and Hellmut Fritzsche. “Electromagnetic Radiation | Spectrum, Examples, & Types.” Encyclopedia Britannica, March 28, 2024. https://britannica.com/science/electromagnetic-radiation.

Walker, Jermaine. “Spectrum Overview - NASA.” NASA (blog), September 27,2023.https://www.nasa.gov/directorates/heo/scan/spectrum/overview/index.html

ANSWER KEY

What Happened?

1. wave	2. crest
3. trough	4. amplitude
5. Wavelength	6. Frequency
7. Range	

Pre-Test

1. a, 2. b, 3. d, 4. b, 5. b, 6. b, 7. b, 8. a, 9. b, 10. d

Post- Test

1. b, 2. b, 3. c, 4. b, 5. d, 6. b, 7. a, 8. a, 9. b, 10. d

Activity 1

1. Greater	2. The same	3. Lesser
4. Greater	5. Lesser	6. Lesser
7 The same		

Activity 2

1.Radiation	2. Mechanical	3.Vacuum
4.Spectrum	5. Photon	6. Energy

Activity 3

1. Gamma	2. Microwave
3. Visible Light	4. Radio Wave
5. Ultraviolet	6. X-Ray
7. Infrared	

SYNOPSIS

Electromagnetic radiation, in classical physics, the flow of energy at the universal speed of light through free space or through a material medium in the form of the electric and magnetic fields that make up electromagnetic waves such as radio waves, visible light, and gamma rays.

Electromagnetic spectrum is the entire distribution of electromagnetic radiation according to frequency or wavelength.

Although all electromagnetic waves travel at the speed of light in a vacuum, they do so at a wide range of frequencies, wavelengths, and photon energies.

ABOUT THE AUTHOR

MARIO JAMES S. DELA CRUZ, Master Teacher I, is an Advanced Physics and Science 10 teacher at Santiago City NHS. In 2020, he was awarded Most Outstanding Secondary Teacher in the Schools Division of Santiago City and a Finalist during the 2020 Regional STARS Awards.

In 2021, he received an international recognition as Luminary Excellence in Education and Research Award- Outstanding Educator in Science.

His work as Science teacher also appreciated in Region 02 and gave him the award Most Outstanding Secondary Teacher and Outstanding Employee Award.

He was awarded as the Grand National Champion in SIM Making at the National Science and Technology Fair in 2020. Recently, he was awarded Grand National Champion in SIM Making spearheaded by the Salindunong Review and Research Center.

He is a Regional Learning Activity Sheet writer and Content Editor. He is a Strategic Intervention Material (SIM) and Self- Learning Kit (SLK) writer.

He continues to contribute to Science Education as a Science Club adviser, academic coach, resource person, lecturer and evaluator at various seminars, conferences and Science fairs.