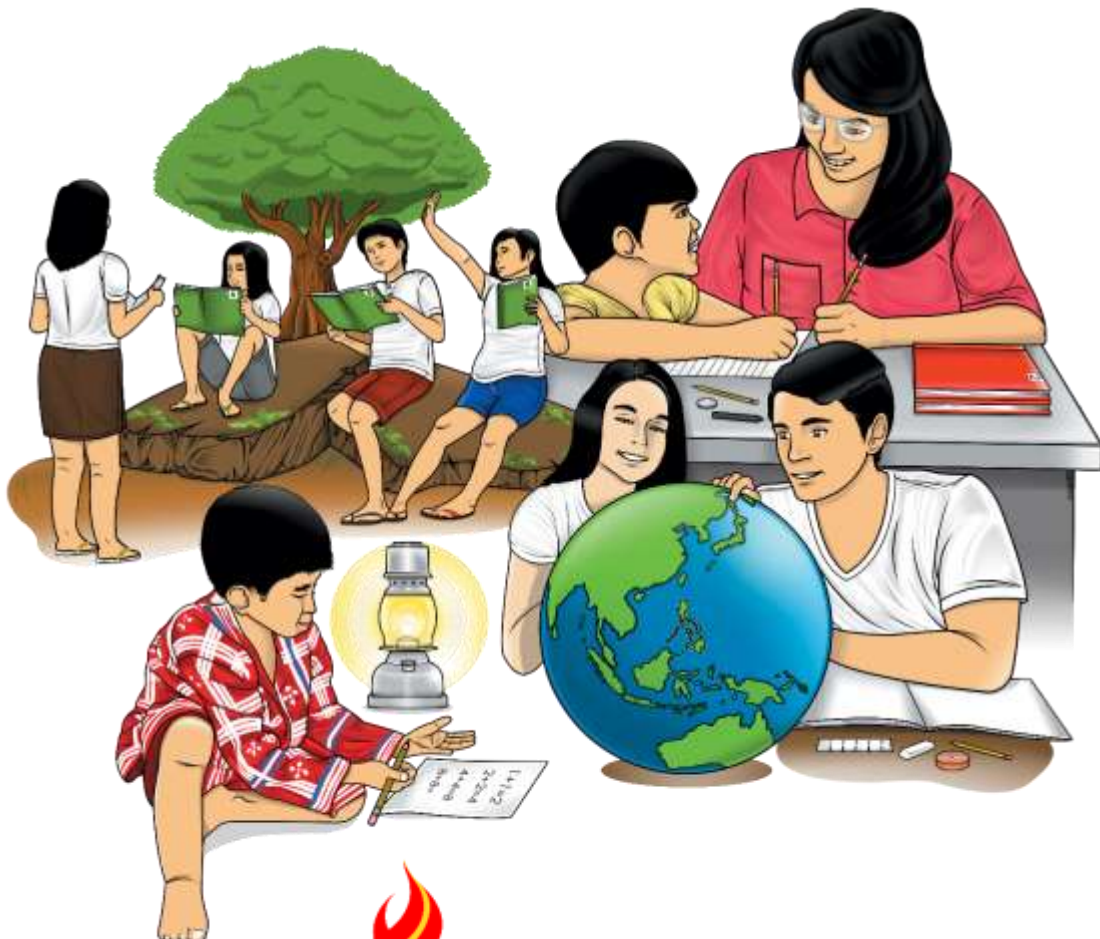


Science

Quarter 2 – Module 1: Different Forms of EM Waves



Science – Grade 10
Alternative Delivery Mode
Quarter 2 – Module 1: Different Forms of EM Waves
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Science

Quarter 2 – Module 1: Different Forms of EM Waves

Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.



What I Need to Know

Electromagnetic radiation is all around us. Some are unnoticeable, yet a lot of our activities make use of these electromagnetic waves from texting to cooking. But what are electromagnetic waves?

This module is specifically crafted to focus on the different activities that will assess your level in terms of skills and knowledge with the expectation to demonstrate through the learning material. Read and answer the suggested tasks and accomplish them to explore and experience the world of electromagnetic spectrum.

After going through this module, you are expected to:

1. compare the relative wavelengths of different forms of electromagnetic waves (**S10FE-IIa-b-47**);
2. compare the relative frequencies of different forms of electromagnetic waves; and
3. identify the relationship among wavelength, frequency and energy of an electromagnetic wave.

Going through this module can be a meaningful learning experience. All you need to do is make use of your time and resources efficiently. To do this, here are some tips for you:

1. **Take the pretest** before reading the rest of the module.
2. **Take time** in reading and understanding the lesson. Follow instructions carefully. Do all activities diligently. This module is designed for independent or self-paced study. It is better to be slow but sure than to hurry and miss the concepts you are supposed to learn.
3. Use a **clean sheet of paper** for your answers in each activity/ assessment.
Don't forget to write your name. Label it properly.
4. Try to **recall and connect the ideas** about waves that you had in the lower years. Use the concept discussed in the lesson to explain the results of activities

or performance tasks. You may answer in English or a combination of your vernacular and English.

5. **Be honest.** When doing the activities, record only what you have really observed. Take the self-assessments after each activity, but do not turn to the Answer Key page unless you are done with the entire module.
6. **Don't hesitate to ask.** If you need to clarify something, approach or contact your teacher or any knowledgeable person available to help you. You may also look into other references for further information. There is a list of reference at the back part of this module.
7. **Take the posttest** prepared at the end of the module, so you can assess how much you have learned from this module.
8. You can **check your answers** in the activities, self-assessments, and posttest after you finished the entire module to know how much you have gained from the lesson and the activities.

Before you continue with this module, let's check how much you know about this topic. An answer key is provided at the end of the module. But do not try to look at it while answering. You can check your answers after you are done with the pre-test.



What I Know

Directions: Read each question carefully. Choose the letter of the correct answer. Use a separate sheet of paper for your answers.

1. These are waves that are created as a result of vibrations between an electric field and magnetic field.
 - a. electromagnetic spectrum
 - b. electromagnetic wave
 - c. microwave
 - d. radio wave
2. Electromagnetic waves are produced by _____.
 - a. any disturbance
 - b. currents
 - c. vibrating charge
 - d. voltage source

3. 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

4. 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

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

6. What happens to the frequency of electromagnetic wave if its wavelength increases?
 - a. It decreases.
 - b. It doubles.
 - c. It. increases as well.
 - d. It remains the same.

7. Which of the following forms of electromagnetic wave has the WIDEST wavelength range?
 - a. microwave
 - b. radio wave
 - c. ultraviolet
 - d. x-ray

8. In the visible spectrum, which color has the LONGEST wavelength?
 - a. blue
 - b. green
 - c. red
 - d. violet

9. Which property spells the difference between infrared and ultraviolet radiation?
 - a. amplitude
 - b. color
 - c. speed in vacuum
 - d. wavelength

10. Which electromagnetic wave can travel the FARTHEST distances because it has a wavelength range of greater than 1×10^{-1} meters?
- gamma ray
 - radio wave
 - microwave
 - x-ray
11. Which among the following electromagnetic waves has the LOWEST frequency?
- gamma ray
 - infrared
 - ultraviolet
 - visible light
12. Which among the following electromagnetic waves has the SHORTEST wavelength?
- infrared
 - microwave
 - radio wave
 - x-ray
13. Among the given EM waves below, which carries the MOST energy?
- microwave
 - radio wave
 - ultraviolet ray
 - visible lights
14. Which of the following statements is CORRECT?
- Gamma ray has the highest frequency and the highest energy.
 - Gamma ray has the highest frequency but has the least energy.
 - Radio wave has the highest frequency and the highest energy.
 - Radio wave has the lowest frequency but has the highest energy.
15. Which of the following is correctly arranged from HIGHEST to LOWEST energy?
- Gamma ray, radio wave, infrared
 - Microwave, x-ray, gamma ray
 - Ultraviolet, visible light, radio wave
 - X-ray, gamma ray, ultraviolet

How did you find the pre-test? What was your score? If you got 15 items correctly, you may skip the module. But if your score is 14 and below, you must proceed with the module.

Lesson**1****Different Forms of EM Waves*****What's In***

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. Do this on a separate sheet of paper.

1.	It is a disturbance in space.	AVWE
2.	It is the highest point in a wave.	SECR T
3.	It is the lowest point in a wave.	TGHURO
4.	It is the distance from the midpoint to the highest (or lowest) point of a wave.	LMUPTDEAI
5.	It is the distance between two successive identical parts of a wave.	ENEVTGWLAH
6.	It refers to the number of waves produced in one second.	NEQFCEURY
7.	It refers to the extent or the limits between which variation is possible.	ARGNE

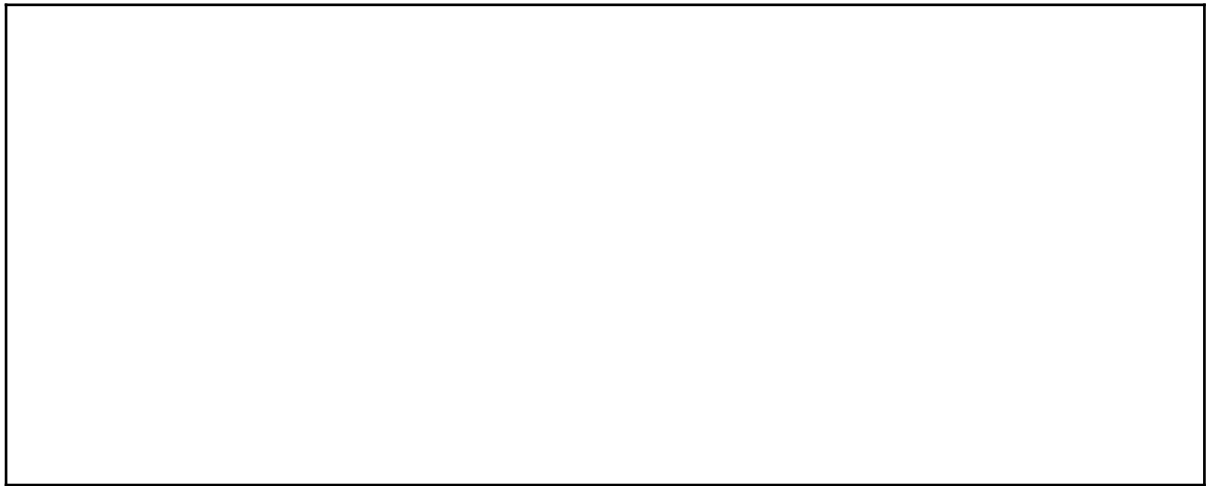
How many words do you remember well? You may refer back to these pages when you want to recall the definition of the listed terms.



What's New

You have probably seen a wave, but have you created one? Let's try and make some waves.

Get a rope of any kind and tie one end of it to a fixed sturdy object near you. Now, straighten the rope and hold the other end of it. Start moving your hands up and down. Observe what happens to the rope. Were you able to make a wave? Draw the wave you made on a separate sheet of paper.



Now, try to make a wave again but move your hands slowly. Observe what happens. Draw the image of the wave you created.



This time, make a wave while moving your hands fast. Draw the image of the wave.

Based on the activity, is there any difference on the waves you have created? Why does each created wave look differently? _____



Note to the Teacher

You may use the following criteria to rate your student's output.

Performance Rubric

Score	Indicators
5 points	All responses are correct.
4 points	All responses are correct but grammatically wrong.
3 points	Some responses are correct.
2 points	None of the responses are correct.
1 point	Did not attempt to answer

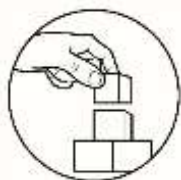


What is It

When you move your hands up and down while holding one end of the rope, you create wave on the rope. The waves you created may look different depending on how fast you move your hand.

Similarly, if you move an electrically charged object back and forth in an empty space, you'll create electromagnetic waves in space. But what is an electromagnetic wave?

Electromagnetic wave (EM wave) or electromagnetic radiation is a wave that is created as a result of vibrations between an electric field and magnetic field, hence known as 'electromagnetic wave'. Recall Oersted's discovery: A changing electric field produces magnetic field. A changing magnetic field is therefore produced around a vibrating charge. And according to Michael Faraday, the changing magnetic field will produce electric field. A wave carries energy as it propagates, EM wave does the same, too. EM waves can travel through anything even on vacuum, meaning they do not need any medium to travel. They travel in a vacuum at a speed of 3×10^8 m/s.



What's More

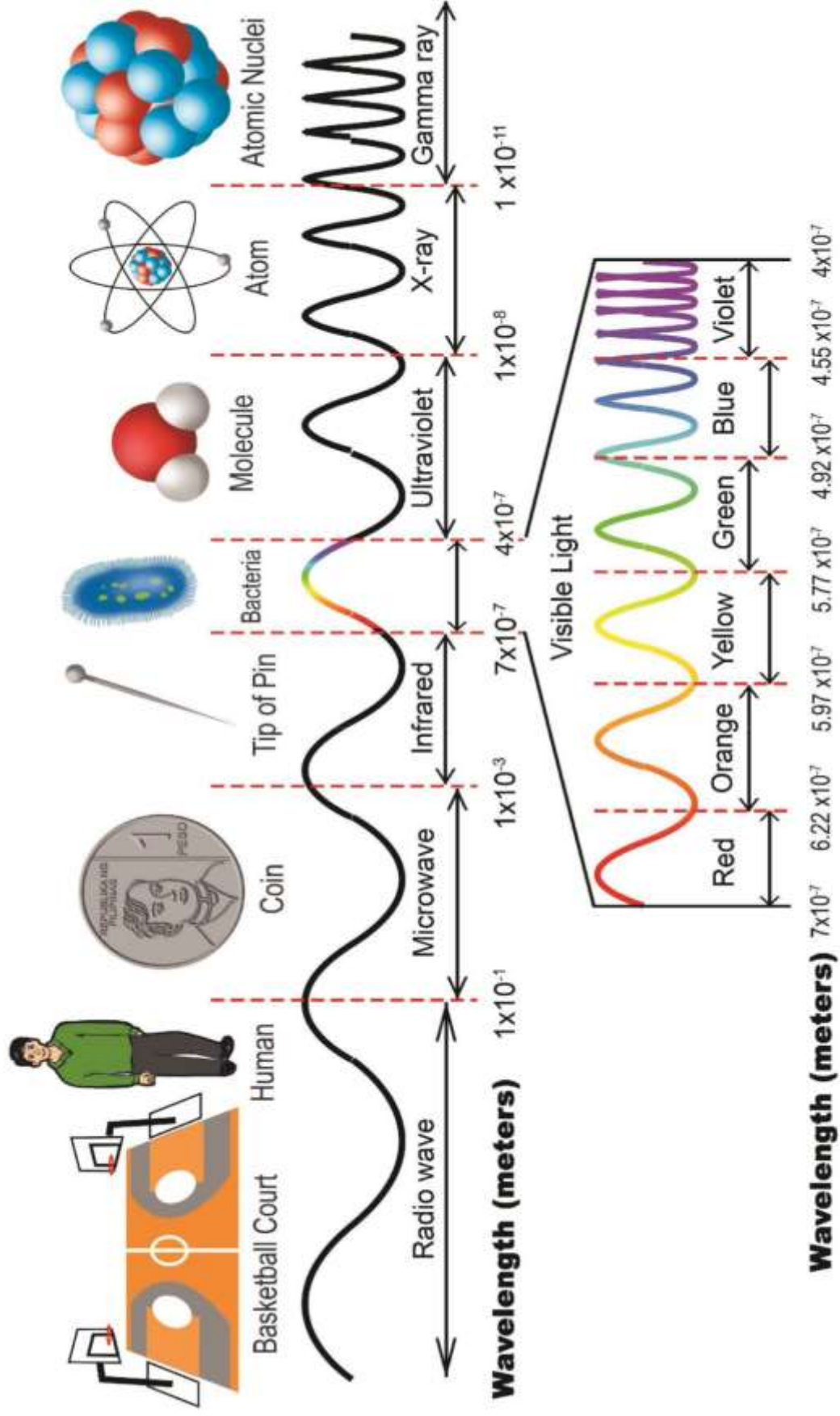
There are seven different types of EM waves. They are arranged in a gradual progression from the waves of lowest frequency to highest frequency. This arrangement of EM waves is called **electromagnetic spectrum**. In order of increasing frequency, the EM spectrum includes radio waves, microwaves, infrared, visible light, ultraviolet, X-ray, and gamma ray.

Now let's strengthen your concepts regarding the different EM waves by comparing their relative wavelengths and frequencies. And as you move along, discover some characteristics of EM waves. So if you're ready to ride the waves, answer the following enrichment activities and dive into the world of EM waves. Have fun!

Enrichment Activity 1

Wavelength is the distance between crest to crest or trough to trough. EM waves are bounded at different ranges. Meaning each type of EM waves has upper and lower limits on the spectrum.

Using Figure 1, determine the wavelength ranges of each of the forms of electromagnetic waves. On a separate sheet of paper, copy and answer the given table on page 13. Afterwards answer the questions that follow.



Electromagnetic Wave	Wavelength Range (meters)
Radio Wave	
Microwave	
Infrared	
Visible Light	
Red	
Orange	
Yellow	
Green	
Blue	
Violet	
Ultraviolet	
X-ray	
Gamma Ray	

Q1. Which electromagnetic wave has the longest wavelength?

Q2. Which electromagnetic wave has the shortest wavelength?

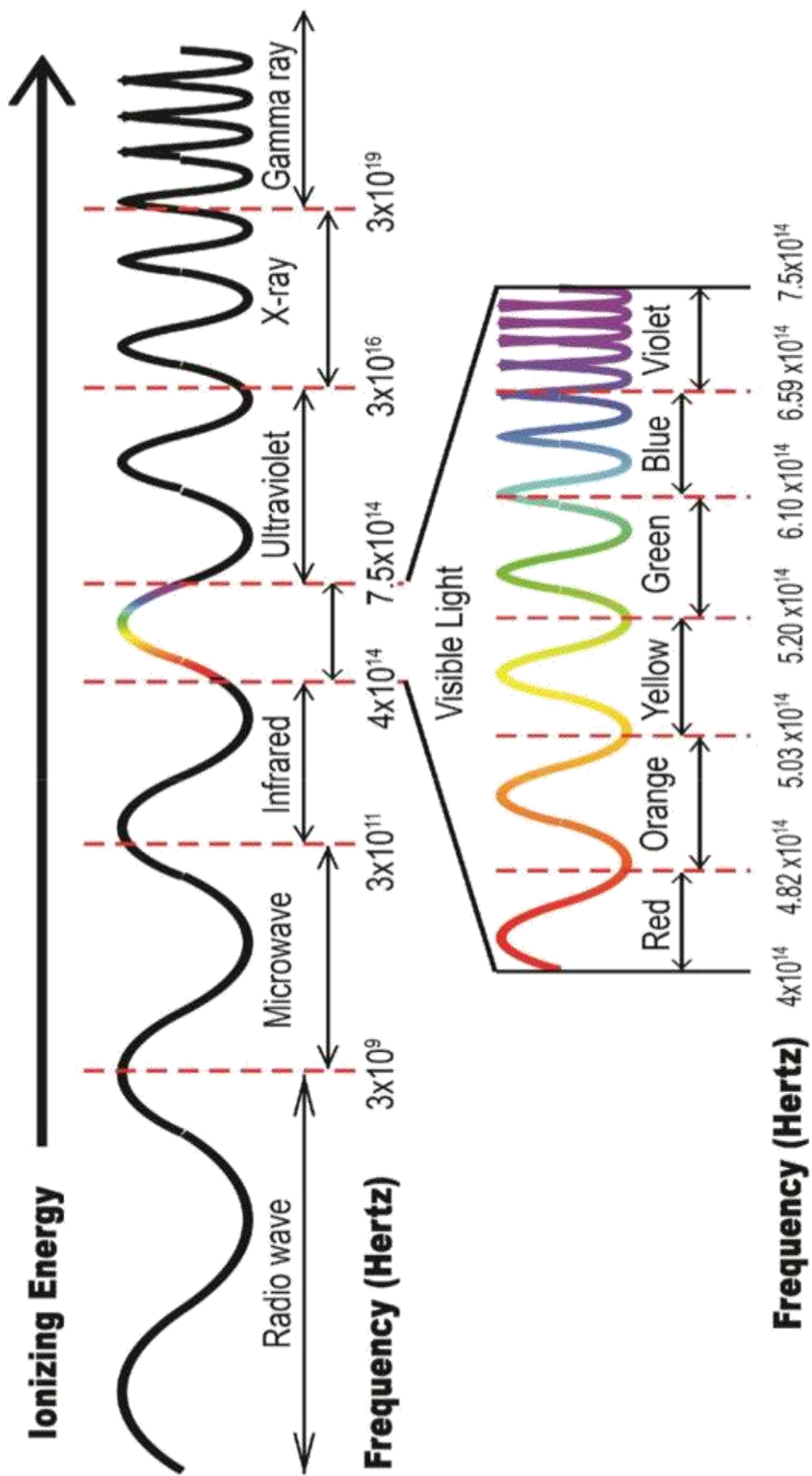
Q3. Observe what happens to the wavelength of the electromagnetic waves as they progress (goes rightward from the figure). Does the wavelength of the EM waves increase or decrease as we go from radio wave to gamma ray?

Directions: Read each item carefully. Write only the letter of your choice. Use a separate sheet of paper for your answers.

1. This type of wave was discovered by famous astronomer Sir Frederick William Herschel and has a range of $7 \times 10^{-7} \text{ m} - 1 \times 10^{-3} \text{ m}$.
 - a. infrared
 - b. microwave
 - c. radio wave
 - d. visible light
2. Which of the following electromagnetic waves has the **least** wavelength range?
 - a. infrared ($7 \times 10^{-7} \text{ m} - 1 \times 10^{-3} \text{ m}$)
 - b. x-ray ($1 \times 10^{-11} \text{ m} - 1 \times 10^{-8} \text{ m}$)
 - c. visible light ($6.22 \times 10^{-7} \text{ m} - 4.55 \times 10^{-7} \text{ m}$)
 - d. ultraviolet ($1 \times 10^{-8} \text{ m} - 4 \times 10^{-7} \text{ m}$)
3. Which among the following EM waves has the **longest** wavelength?
 - a. infrared
 - b. ultraviolet
 - c. visible light
 - d. x-ray
4. Which electromagnetic wave can travel the **farthest** distances because it has a wavelength range of greater than $1 \times 10^{-1} \text{ m}$?
 - a. gamma ray
 - b. microwave
 - c. radio wave
 - d. x-ray
5. The wavelength of microwaves ranges from $1 \times 10^{-1} \text{ m}$ to $1 \times 10^{-3} \text{ m}$. Which of the following has size comparable to the wavelength of microwave?
 - a. Bacteria
 - b. Coin
 - c. Human
 - d. Pin

Enrichment Activity 2

Next up, let us compare the frequencies of different EM waves. Copy and answer the table on page 16, refer to Figure 2, then answer the questions that follow. Use a separate sheet of paper for your answer.



Electromagnetic Wave	Wavelength Range (meters)
Radio Wave	
Microwave	
Infrared	
Visible Light	
Red	
Orange	
Yellow	
Green	
Blue	
Violet	
Ultraviolet	
X-ray	
Gamma Ray	

Q1. Which among the EM waves has the highest frequency?

Q2. Which among the EM waves has the lowest frequency?

Q3. The energy of an EM wave also depends on its frequency, which means waves with higher frequency has higher energy too. Which among the EM waves has the highest energy? _____

Q4. Which among the EM waves has the lowest energy?

Q5. What happens to the frequency of the electromagnetic waves as it progresses? Does the frequency of the EM waves increase or decrease as we go from radio wave to gamma ray?

Assessment 2

Directions: Read each item carefully. Write only the letter of your choice. Use a separate sheet of paper for your answers.

1. 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
2. A visible light has a frequency of 6.3×10^{14} Hz. What is the color of light?
 - a. blue
 - b. green
 - c. red
 - d. yellow
3. Which among the following EM waves has the HIGHEST frequency among others?
 - a. infrared
 - b. microwave
 - c. ultraviolet
 - d. x-ray
4. Which of the following EM waves has the LEAST amount of energy?
 - a. gamma ray
 - b. microwave
 - c. radio wave
 - d. x-ray
5. 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.

Enrichment Activity 3

Now that you are already familiar with the wavelength and frequency of EM waves, on a separate sheet of paper, copy and complete the table below. Identify what happens to the wavelength, frequency and energy of the EM waves following the direction of the arrows. You may answer INCREASING or DECREASING inside the arrows.

Electromagnetic Wave	Wavelength	Frequency	Energy
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Radio Wave

Microwave

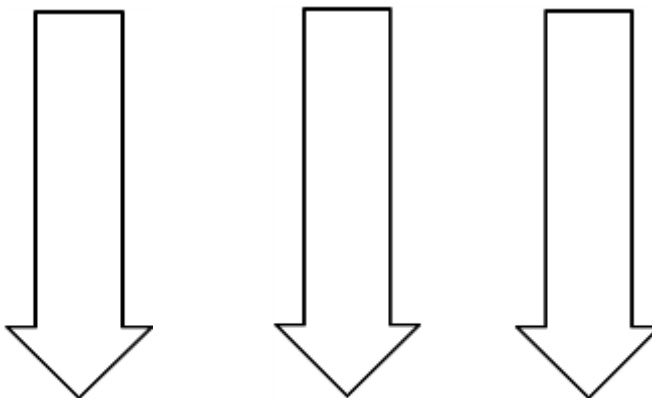
Infrared

Visible Light

Ultraviolet

X-ray

Gamma Ray



Assessment 3

Directions: Read each item carefully. Pick out the correct answer. Use a separate sheet of paper for your answers.

1. Which has shorter wavelength?

X-Rays or *Gamma rays*

2. Which has higher frequency?

Visible light or *Ultraviolet*

3. Which has more energy?

Radio waves or *Infrared*

4. Which has longer wavelength on visible light?

Green Light or *Blue Light*

5. Which has lesser frequency?

Microwave or *Gamma ray*

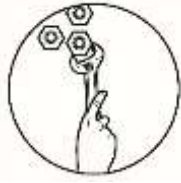


What I Have Learned

At this point, let's sum up what you have learned. Pick out the word that will make the statements correct. Write your answer on a separate sheet of paper.

The electromagnetic spectrum is the arrangement of 1. (electromagnetic waves, ultraviolet radiation), which are waves that are created with changing electric field and 2. (electric charge, magnetic field). EM waves travel on 3. (air, vacuum) at a constant speed of 4. (3×10^8 m/s, 8×10^3 m/s).

The electromagnetic spectrum is arranged in a manner of 5. (decreasing, increasing) wavelength, 6. (decreasing, increasing) frequency and 7. (decreasing, increasing) energy. 8. (Gamma ray, Radio wave) has the longest wavelength, lowest frequency and lowest energy among all EM waves. The 9. (radio wave, visible light) is the only EM wave that can be seen by our naked eye, whereas 10. (red, violet) has the longest wavelength and 11. (red, violet) has the greatest frequency. On the other hand, 12. (gamma ray, radio wave) has the shortest wavelength and highest frequency; which carries the highest 13. (energy, wavelength) among all EM waves. Therefore 14. (gamma ray, radio wave) has the lowest ionizing radiation, while 15. (gamma ray, radio wave) has the highest ionizing radiation.



What I Can Do

For sure you are now acquainted with the different electromagnetic waves. It's your turn to make your own chart about electromagnetic waves.

Make a chart of electromagnetic waves showing the comparison of its size. Cut out pictures of objects or look for things that may represent the size of each electromagnetic wave. On a separate sheet of paper, paste the pictures you have found and arrange them according to the arrangement of EM waves in the electromagnetic spectrum.

Standard Rubric

You will be rated by your teacher according to the following criteria:

Accuracy of Information	5 points
Neatness of Work	5 points
Appropriateness of Materials	5 points

TOTAL 15 points



Assessment

Directions: Read each question carefully. Choose the letter of the correct answer. Use a separate sheet of paper for your answers.

1. He theorized that changing magnetic field will produce electric field.
a. Faraday c. Maxwell
b. Hertz d. Oersted
2. Electromagnetic waves can travel through a vacuum. What is the speed of an electromagnetic wave in a vacuum?
a. 3×10^8 m/s c. 3×10^9 m/s
b. 3×10^8 m/s² d. 3×10^9 m/s²
3. Which property spells the difference between radio wave and microwave radiation?
a. amplitude c. speed in vacuum
b. color d. wavelength

4. Which two waves lie at the beginning and end of the electromagnetic spectrum?
 - a. gamma ray and X-ray
 - b. microwave and ultraviolet rays
 - c. radio wave and gamma ray
 - d. radio waves and microwaves

5. What is the frequency range of ultraviolet radiation?
 - a. $3.5 \times 10^9 - 3 \times 10^{11}$ Hz
 - b. $3.5 \times 10^{11} - 3 \times 10^{14}$ Hz
 - c. $7.5 \times 10^{14} - 3 \times 10^{16}$ Hz
 - d. $7.5 \times 10^{16} - 3 \times 10^{19}$ Hz

6. Visible light is the only EM wave that can be seen by our naked eye. What is the color of light if it has a frequency of 4.5×10^{14} Hz?
 - a. blue
 - b. green
 - c. red
 - d. yellow

7. Which of the following is correctly arranged from longest to shortest wavelength?
 - a. gamma ray, radio wave, infrared
 - b. microwave, x-ray, gamma ray
 - c. ultraviolet, visible light, radio wave
 - d. x-ray, gamma ray, ultraviolet

8. Which type of EM wave has wavelength similar to the size of a 1 Peso coin?
 - a. infrared
 - b. microwave
 - c. ultraviolet
 - d. visible light

9. Which electromagnetic wave can travel the least distances because it has a wavelength range of less than 1×10^{-11} meters but has the highest energy?
 - a. gamma ray
 - b. microwave
 - c. radio wave
 - d. x-ray

10. In the electromagnetic spectrum, which has the longest wavelength?
 - a. gamma ray
 - b. radio wave
 - c. ultraviolet
 - d. visible light

11. What happens to the frequency of electromagnetic wave if its wavelength increases?
 - a. decreases
 - b. doubles
 - c. increases as well
 - d. remains the same

12. In the visible spectrum, which color has the shortest wavelength?
a. blue c. red b. green d. violet
13. Which of the following statements is correct?
a. As the frequency of a wave increases, the wavelength also increases.
b. As the frequency of a wave decreases, the energy increases.
c. As the wavelength of a wave increases, the energy also increases.
d. As the wavelength of a wave decreases, the frequency increases.
14. Among the given EM waves below, which carries the most energy?
a. microwave
b. radio wave
c. ultraviolet ray
d. visible light
15. Which of the following is correctly arranged from lowest to highest energy?
a. microwave, visible light, radio wave
b. ultraviolet, radio wave, infrared
c. visible light, ultraviolet, gamma ray
d. x-ray, gamma ray, ultraviolet



Answer Key

What I Know (Pretest)

- 1. B
- 2. C
- 3. A
- 4. B
- 5. C
- 6. A
- 7. B
- 8. C
- 9. D
- 10. C
- 11. B
- 12. D
- 13. C
- 14. A
- 15. C

What's In

- 1. Wave
- 2. Crest
- 3. Trough
- 4. Amplitude
- 5. Wavelength
- 6. Frequency
- 7. Range

Enrichment Activity 1

- Q1. Radio Wave
- Q2. Gamma Ray
- Q3. The wavelength of EM waves decreases

Electromagnetic Wave	Wavelength Range (meters)
Radio Wave	$> 1 \times 10^1$
Microwave	$1 \times 10^{-3} - 1 \times 10^1$
Infrared	$7 \times 10^{-7} - 1 \times 10^{-3}$
Visible Light	$6.22 \times 10^{-7} - 4.55 \times 10^{-7}$
Red	$6.22 \times 10^{-7} - 7 \times 10^{-7}$
Orange	$5.97 \times 10^{-7} - 6.22 \times 10^{-7}$
Yellow	$5.77 \times 10^{-7} - 5.97 \times 10^{-7}$
Green	$4.92 \times 10^{-7} - 5.77 \times 10^{-7}$
Blue	$4.55 \times 10^{-7} - 4.92 \times 10^{-7}$
Violet	$4 \times 10^{-7} - 4.55 \times 10^{-7}$
Ultraviolet	$1 \times 10^{-8} - 4 \times 10^{-7}$
X-ray	$1 \times 10^{-11} - 1 \times 10^{-8}$
Gamma Ray	$< 1 \times 10^{-11}$

Assessment 1

- 1. A
- 2. C
- 3. A
- 4. C
- 5. B

Enrichment Activity 2

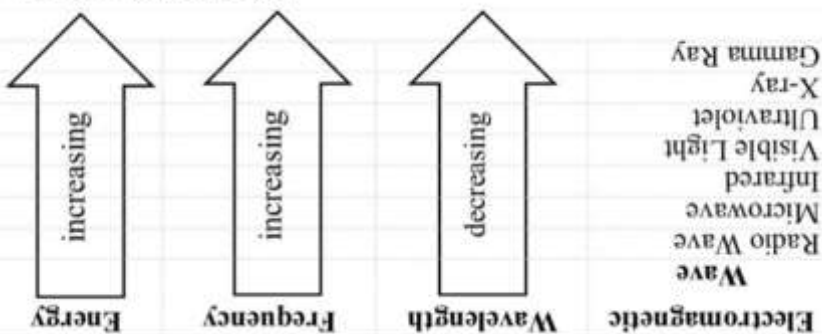
- Q1. Gamma ray
- Q2. Radio Wave
- Q3. Gamma ray
- Q4. Radio wave
- Q5. The frequency of EM wave increases

Electromagnetic Wave	Frequency Range (Hz)
Radio Wave	$< 3 \times 10^9$
Microwave	$3 \times 10^9 - 3 \times 10^{11}$
Infrared	$3 \times 10^{11} - 4 \times 10^{14}$
Visible Light	$4 \times 10^{14} - 7.5 \times 10^{14}$
Red	$4 \times 10^{14} - 4.82 \times 10^{14}$
Orange	$4.82 \times 10^{14} - 5.03 \times 10^{14}$
Yellow	$5.03 \times 10^{14} - 5.20 \times 10^{14}$
Green	$5.20 \times 10^{14} - 6.10 \times 10^{14}$
Blue	$6.10 \times 10^{14} - 6.59 \times 10^{14}$
Violet	$6.59 \times 10^{14} - 7.5 \times 10^{14}$
Ultraviolet	$7.5 \times 10^{14} - 3 \times 10^{16}$
X-ray	$3 \times 10^{16} - 3 \times 10^{19}$
Gamma Ray	$> 3 \times 10^{19}$

Assessment 2

- 1. B
- 2. A
- 3. D
- 4. C
- 5. A

Enrichment Activity 3



Assessment 3

1. Gamma rays
2. Ultraviolet
3. Infrared
4. Green light
5. Gamma ray

What Have I Learned

1. Electromagnetic waves
2. Magnetic field
3. Vacuum
4. 3×10^8 m/s
5. Decreasing
6. Increasing
7. Increasing
8. Radio wave
9. Visible light
10. Red
11. Violet
12. Gamma rays
13. Energy
14. Radio wave
15. Gamma rays

Assessment (Post Test)

1. A
2. A
3. D
4. C
5. C
6. C
7. B
8. B
9. A
10. B
11. A
12. D
13. D
14. C
15. C

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