

Department of Education
National Capital Region
SCHOOLS DIVISION OFFICE
MARIKINA CITY

Science

Quarter 2 – Module 3

Effects of Electromagnetic Radiation

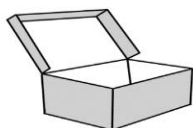


Loisa D. Tolentino



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What I Need to Know

The purpose of this module is to help you understand the nature of the different regions of the electromagnetic spectrum. The module is divided into two lessons, namely:

- Lesson 1 – Non-ionizing and Ionizing Radiation
- Lesson 2 – Safety and Importance of Electromagnetic Radiation

After going through this module, you are expected to **explain the effects of EM radiation on living things and the environment. S10FE-IIe-f-49**

Specifically, you are expected to:

- classify EM waves as ionizing and non-ionizing radiation using the energy levels;
- explain the effects of EM waves applications on living things and the environment;
- evaluate the risks and benefits derived from the applications of EM waves; and
- explain the principle of EM radiation safety and its importance in society.



What I Know

Read and understand each item carefully and encircle the letter of the correct answer.

1. What form of electromagnetic radiation has the most energy?
 - A. X-rays
 - B. Microwaves
 - C. Gamma-rays
 - D. Radio waves
2. What is the difference between ionizing and non-ionizing radiation?
 - A. Non-ionizing radiation is high energy radiation, but ionizing radiation is low energy radiation.
 - B. Ionizing radiation has high energy that can remove an electron from the atom, but non-ionizing does not.
 - C. Non-ionizing radiation is a naturally occurring phenomenon and ionizing radiation is only created artificially.
 - D. Ionizing radiation is a naturally occurring phenomenon and non-ionizing radiation is only created artificially.



3. Which is **NOT** a probable result of the human tissue's exposure to ionizing radiation?
 - A. Death
 - B. Cancer
 - C. Viral infection
 - D. Cellular damage

4. What does ionizing radiation remove from atoms?
 - A. Protons
 - B. Nucleus
 - C. Electrons
 - D. Neutrons

5. How can we protect ourselves from harmful electromagnetic radiation?
 - A. Limit sun exposure
 - B. Spend time outdoors
 - C. Increase cell phone use
 - D. Put your wireless smartphone near

6. Which is the example of non-ionizing radiation?
 - A. X-ray
 - B. Gamma ray
 - C. Visible light
 - D. Ultraviolet ray

7. Which describes a non-ionizing radiation?
 - A. It can remove an electron from an atom.
 - B. It has a higher frequency and wavelength.
 - C. It does not have enough energy to ionize atoms.
 - D. It has a higher frequency and shorter wavelength.

8. Which condition is **NOT** caused by overexposure to UV light?
 - A. Sunburn
 - B. Cataracts
 - C. Cross eyes
 - D. Skin cancer

9. Which group of EM waves is considered as ionizing radiation?
 - A. Radio wave, Infrared and Visible light
 - B. High Ultraviolet, X-ray, and Gamma Ray
 - C. Infrared, Microwave, and High Ultraviolet
 - D. Gamma Ray, High Ultraviolet and Visible Light

10. Which group of EM waves is considered as non-ionizing radiation?
 - A. Gamma Ray, X-ray, Ultraviolet and Microwave
 - B. Visible light, Ultraviolet, X-ray, and Gamma Ray
 - C. Radio wave, Microwave, Infrared and Visible light
 - D. Microwave, Radio wave, Visible light, and Gamma ray



Lesson 1

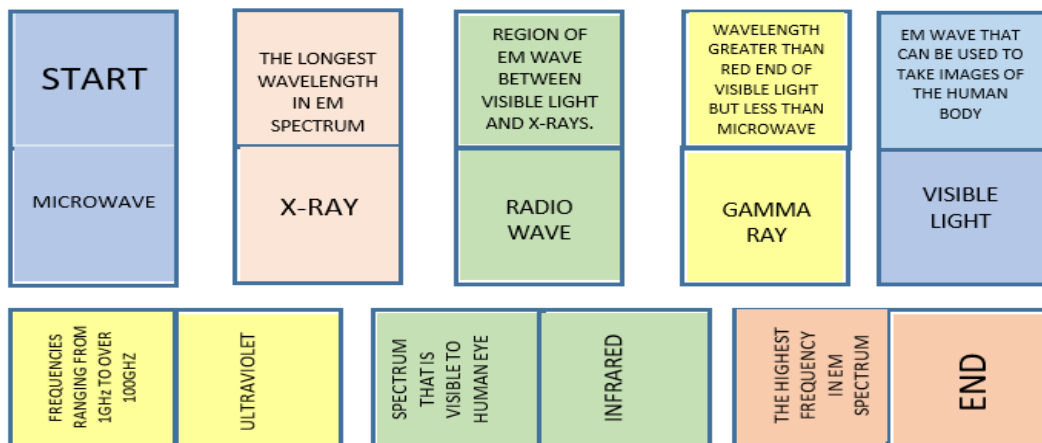
Non-ionizing and Ionizing Radiation



What's In

The properties of electromagnetic waves affect how various waves behave and how they can be used.

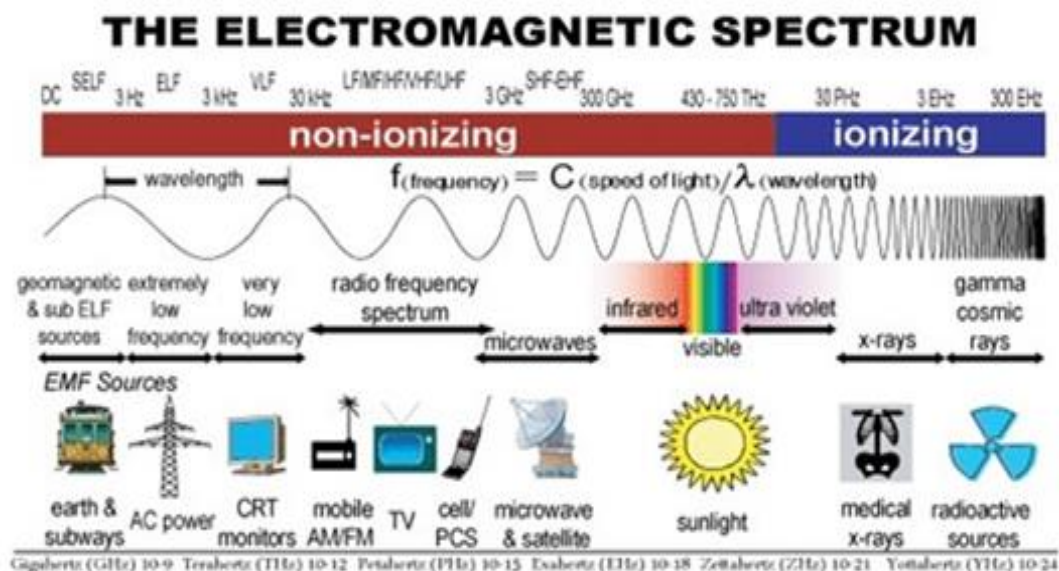
Let us now find out how much you remembered about the electromagnetic spectrum by playing this domino game. Have a template of the domino pieces at the last page of lesson 1. Cut and match the dominoes so that the types of electromagnetic waves match its correct description.



What's New

Activity: TYPES OF ELECTROMAGNETIC RADIATION

Study the diagram of the electromagnetic radiation. Describe what you observed in the image. Then answer the questions that follow.



ELECTROMAGNETIC SPECTRUM created CK-12 is licensed under CC BY-NC 3.0

Guide Questions:

1. What type of radiation is characterized by high frequency, high energy, and short wavelength? Identify the different types of EM waves belonging to this group.
2. What type of radiation is characterized by low frequency, low energy, and long wavelength? Identify the different types of EM waves belonging to this group.
3. Enumerate the source of energy that is harmful and not completely harmless. Identify to what spectra they belong?
3. Differentiate between non-ionizing radiation and ionizing radiation based on the diagram above.

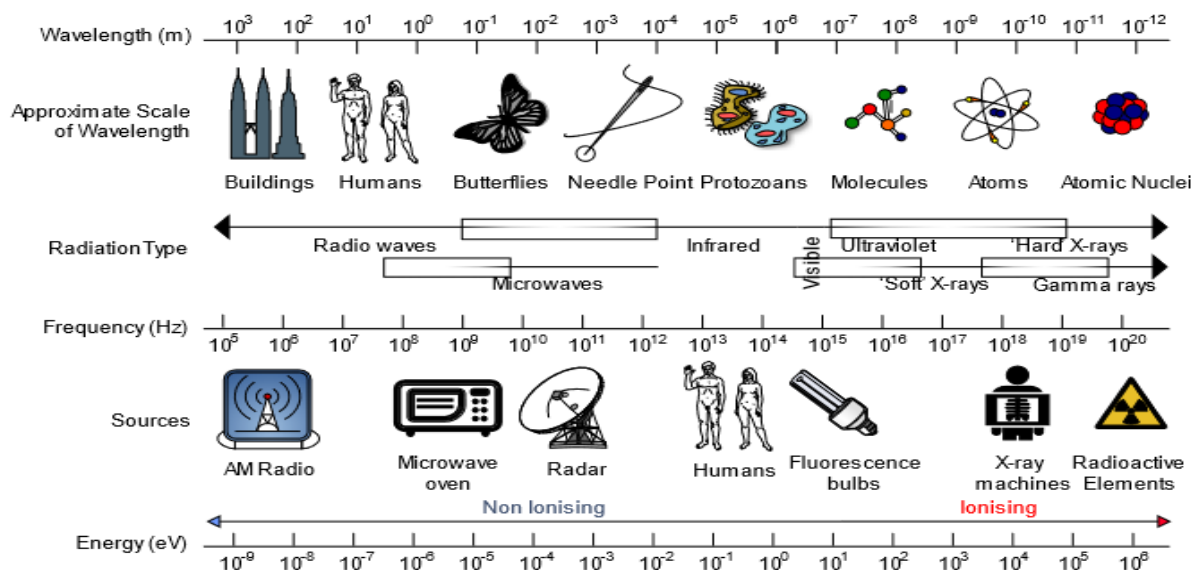


What Is It

THE ELECTROMAGNETIC RADIATION

RADIATION is the energy released from a source as either waves or particles(photons) and creates the electromagnetic spectrum. Electromagnetic radiation is pure energy that can travel as waves through matter or space while particle radiation is a high energy particle removed from the nuclei of atoms.

Radiation within the electromagnetic spectrum is divided into two main types: non-ionizing radiation and ionizing radiation. The diagram below shows the frequencies and wavelengths of the types of radiation.



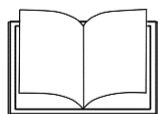
https://commons.wikimedia.org/wiki/File:EM_Spectrum_Properties_edit.svg

Non-ionizing and Ionizing Radiation

The dividing line between ionizing and non-ionizing radiation occurs in the ultraviolet part of the electromagnetic spectrum as shown in the illustration above. Radiation in the ultraviolet band and at lower energies (to the left of ultraviolet) is called non-ionizing radiation, while at the higher energies to the right of ultraviolet band is called ionizing radiation.

Non-ionizing radiation is low energy radiation, it can heat up atoms and molecules. It includes the spectrum of radio waves, microwaves, infrared, visible light, and low energy ultraviolet light (UV-A & UV-B). For example: A microwave oven has enough energy to cook food because when food absorbs microwaves, it causes the water molecules in the food to vibrate and produce heat. Unprotected exposure to UV-A and UV-B can damage the skin cells causing sunburn, premature aging, and skin cancer.

Ionizing radiation is high energy radiation that is strong enough to remove an electron from an atom or molecules. It contains the spectrum of high energy ultraviolet light (UV-C), X-rays, and gamma rays. High doses of ionizing radiation absorbed by living cells can damage their genetic material (DNA). The body cells are effective at repairing this damage. But, if the damage does not repair properly, the cell may die or become cancerous.



What's More

Provide the information to complete the difference between non-ionizing and ionizing radiation.

	Non-ionizing Radiation	Ionizing Radiation
Definition		
Energy (high or low)		
Wavelength (long or short)		
Frequency (high or low)		
Examples		



What I Have Learned

Let us figure out if the electromagnetic radiation is ionizing or non-ionizing. Put **NR** if it is non-ionizing radiation and **IR** if it is ionizing radiation.

- _____ 1. The energy used in the microwave oven to heat our food.
- _____ 2. The energy from the antenna of the radio station.
- _____ 3. The bone scan was used to determine fractures.
- _____ 4. The light I can see with the naked eye.
- _____ 5. The ultraviolet B rays that cause sunburn.



What I Can Do

One of the famous applications of ionizing radiation is nuclear radiation. In your opinion, what are the advantages and disadvantages of using nuclear power plants as a source of electrical energy in our country?



Assessment

Complete the statements below. Underline the correct answer inside the parentheses.

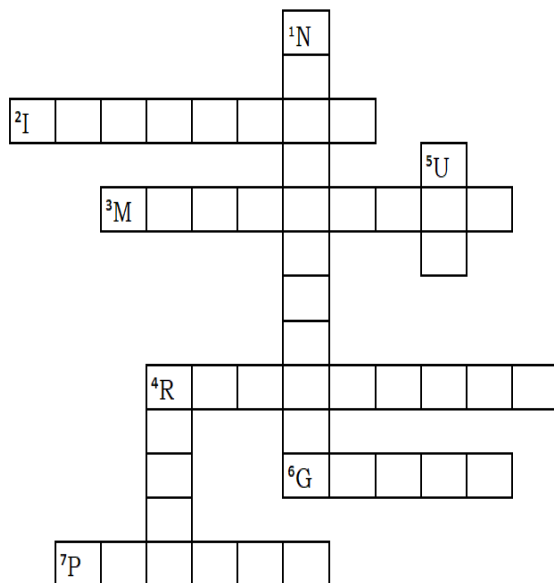
- _____ (*EM wave; EM radiation*) is the energy that travels in the form of waves or speeding particles (photons) and makes up the electromagnetic spectrum.
- _____ (*Ionizing radiation; Non-ionizing radiation*) has sufficient energy to eliminate electrons from atoms and produces ions.
- _____ (*Ionizing radiation; Non-ionizing radiation*) does not have sufficient energy to ionize atoms.
- Radiation from many _____ (*X-ray; radio waves*) exposures could be unsafe because of its high energy.
- Microwaves have enough energy to cook food and _____ (*infrared; ultraviolet light*) can cause sunburn.



Additional Activities

Electromagnetic Radiation Vocabulary Crossword Puzzle

Use your knowledge of the terms from this module to complete the crossword puzzle.



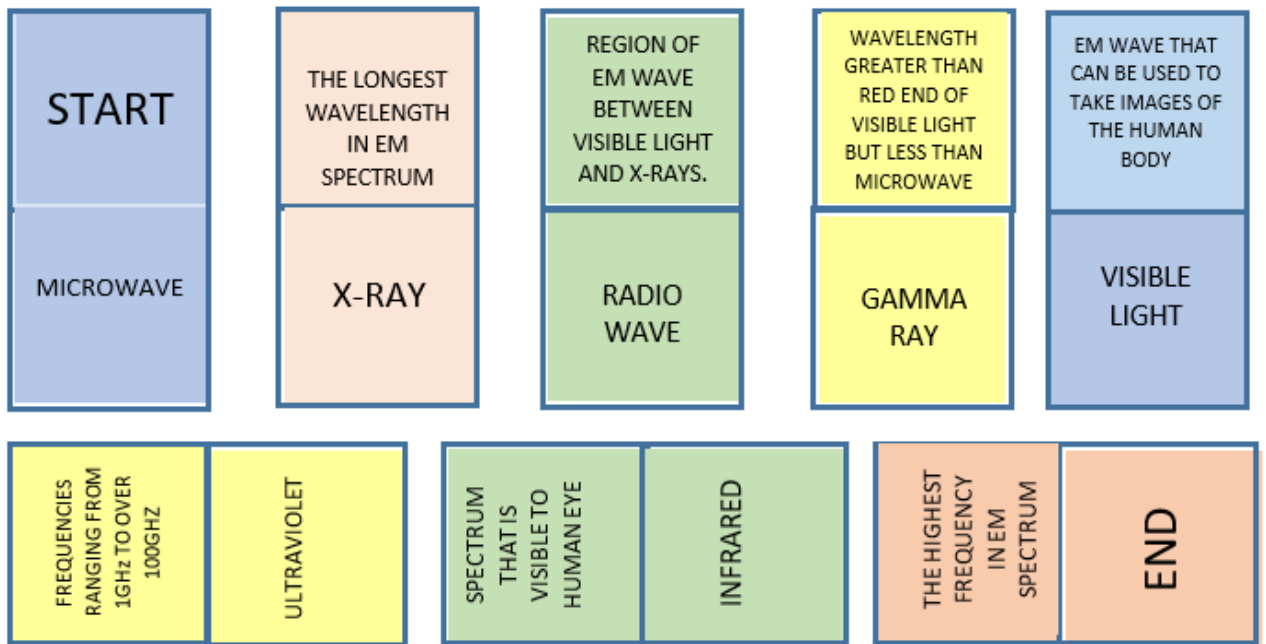
Across:

- Have sufficient energy to ionize atoms.
- Have enough energy to cook food.
- Energy that travels in the form of waves or particles.
- X-rays and _____ can produce cancer and kill cells.
- Speeding particles.

Down:

- No sufficient energy to ionize atoms.
- Non-ionizing radiation with lowest energy.
- Ultraviolet radiation with low frequency and energy.

Template of Electromagnetic Domino



Lesson 2

Safety and Importance of Electromagnetic Radiation



What's In

Fill in the chart below to classify EM radiation. Choose your answer from the box below.

Gamma Ray, Infrared, Ultraviolet, Microwave, Radio wave, X – ray, Visible Light

CLASSIFYING ELECTROMAGNETIC RADIATION

Non-ionizing Radiation	Ionizing Radiation



What's New

The sun is more essential to us on Earth. It helps us grow plants and keep our bodies warm. The human health benefits of sun exposure are through vitamin D, but it can be harmful in large amounts, which is the reason why sunscreens are invented. So, why do we have to wear sunscreen?



What Is It

RADIATION HEALTH EFFECTS AND PROTECTIONS

Electromagnetic radiation from both natural and artificial sources in the environment has many uses. It is used in the field of academics, industry, and medicine. It has useful applications in agriculture, geology, space exploration, and many more.

Radiation can be beneficial, but it can be harmful. EM spectrum has a different degree of energy that can harm the environment. Exposure to radiation even for a short period of a time can cause burns, skin diseases and radiation

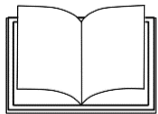
poisoning to humans and animals. If the amount of radiation can be controlled such as gamma rays, it can treat cancer cells. But long-term radiation exposure can cause genetic defects.

Human health and the environment must be protected against the harmful effects of radiation. The International Atomic Energy Agency (IAEA) formulated the standard radiation safety principles including the time of exposure, shielding, and distance.

Time of Exposure. The amount of radiation dosage is directly proportional to the time exposure. Therefore, if the amount of radiation dosage increases, the time of exposure is also increasing. For example, if you spend a lot of time on the street, you will be exposed to the sun, and get a sunburn. Spend less time under the sun and more time in the shade, your sunburn will be less severe.

Shielding. In handling radioactive materials, additional armor/protective materials are placed between the person and the source of radiation to absorb most of its radiation. For instance, wrinkle-causing UV-A rays and burn-inducing UV-B's can pose a serious risk to your health. Sunscreen protection with SPF (sun protection factor) of at least 30 is used to shield skin from the sun's harmful ultraviolet radiation.

Distance. It refers to how near you are to a radiation source. Increasing the distance from the radiation source can reduce radiation exposure. Therefore, maintaining a greater distance from the X-ray generator is very effective to lessen radiation exposure.

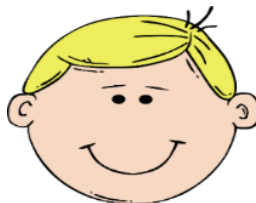


What's More

Ozone layer depletion decreases our atmosphere's natural protection from the sun's harmful ultraviolet (UV) radiation. Do you know how to protect yourself from the harmful effects of ultraviolet radiation emitted by the sun? List **five safety precautions** which you can apply to help you enjoy the sun while reducing your chances of sun-related health problems.

PROTECT YOURSELF FROM

RADIATION





What I Have Learned

Answer the questions below about how to protect yourself from radiation

1. What makes radiation dangerous to humans?
2. Why do we need to protect our bodies from radiation?
3. What precautionary measures must be used to ensure the safety of human beings against harmful radiation?



What I Can Do

Your task is to create an infographic about the different benefits and risks of electromagnetic radiation. This can help disseminate the information that radiation is not always harmful to human life.

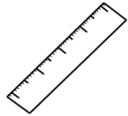
Infographic Rubric

CATEGORY	4	3	2	1
Graphics/Pictures	Graphics go well with the text and there is a good mix of text and graphics.	Graphics go well with the text, but there are so many that they distract from the text.	Graphics go well with the text, but there are too few and the brochure seems "text-heavy".	Graphics do not go with the accompanying text or appear to be randomly chosen.
Attractiveness & Organization	The brochure has exceptionally attractive formatting and well-organized information.	The brochure has attractive formatting and well-organized information.	The brochure has well-organized information.	The brochure's formatting and organization of material are confusing to the reader.
Content - Accuracy	All facts in the brochure are accurate.	99-90% of the facts in the brochure are accurate.	89-80% of the facts in the brochure are accurate.	Fewer than 80% of the facts in the brochure are accurate.
Graphics/Pictures	Graphics go well with the text and there is a good mix of text and graphics.	Graphics go well with the text, but there are so many that they distract from the text.	Graphics go well with the text, but there are too few and the brochure seems "text-heavy".	Graphics do not go with the accompanying text or appear to be randomly chosen.
Sources	Careful and accurate records are kept to document the source of 95-100% of the facts and graphics in the brochure.	Careful and accurate records are kept to document the source of 94-85% of the facts and graphics in the brochure.	Careful and accurate records are kept to document the source of 84-75% of the facts and graphics in the brochure.	Sources are not documented accurately or are not kept on many facts and graphics.



Additional Activities

Write down three (3) ways on how we can protect our environment from the harmful X- Ray radiation. Do this on a separate sheet of paper.



Assessment

Write **T** if the statement is true and **F** if the statement is false.

1. A greater distance from the radiation source can reduce radiation exposure.
2. A very low dose of radiation exposure can cause burns and radiation poisoning.
3. The amount of radiation dosage is directly proportional to the time exposure.
4. Short-term radiation exposure can cause genetic defects and cancer.
5. EM radiation is used in the field of academics, industry, and medicine.



Posttest

Read and understand each item carefully and encircle the letter of the correct answer.

1. What does non-ionizing radiation mean?
 - A. It can remove an electron from an atom.
 - B. It does not have enough energy to ionize atoms.
 - C. It has a higher frequency and shorter wavelength.
 - D. It has a higher frequency and wavelength.
2. Which condition is **NOT** caused by overexposure to UV light?
 - A. Sunburn
 - B. Cataracts
 - C. Cross eyes
 - D. Skin cancer
3. Which group of EM waves is considered as ionizing radiation?
 - A. Ultraviolet, X-ray, and Gamma Ray
 - B. Infrared, Microwave, and Ultraviolet
 - C. Radio wave, Infrared and Visible light
 - D. Gamma Ray, Ultraviolet and Visible Light

4. Which group of EM waves is considered non-ionizing radiation?
 - A. Gamma Ray, X-ray, Ultraviolet and Microwave
 - B. Visible light, Ultraviolet, X-ray, and Gamma Ray
 - C. Radio wave, Microwave, Infrared and Visible light
 - D. Microwave, Radio wave, Visible light, and Gamma ray

5. What form of electromagnetic radiation has the most energy?

A. X-rays	C. Gamma-rays
B. Microwaves	D. Radio waves

6. What is the difference between ionizing and non-ionizing radiation?
 - A. Non-ionizing radiation is high energy radiation, but ionizing radiation is low energy radiation.
 - B. Ionizing radiation has high energy that can remove an electron from the atom, but non-ionizing does not.
 - C. Non-ionizing radiation is a naturally occurring phenomenon and ionizing radiation is only created artificially.
 - D. Ionizing radiation is a naturally occurring phenomenon and non-ionizing radiation is only created artificially.

7. Which is **NOT** a probable result of the human tissue's exposure to ionizing radiation?

A. Death	C. Viral infection
B. Cancer	D. Cellular damage

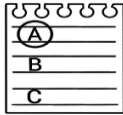
8. What does ionizing radiation remove from atoms?

A. Protons	C. Electrons
B. Nucleus	D. Neutrons

9. How can we protect ourselves from harmful electromagnetic radiation?
 - A. Limit sun exposure
 - B. Spend time outdoors
 - C. Increase cell phone use
 - D. Put your wireless smartphone near

10. Which is an example of a non-ionizing radiation?
 - A. X-ray
 - B. Gamma ray
 - C. Visible light
 - D. Ultraviolet ray





Answer Key

LESSON 1



What's New

Activity: TYPES OF ELECTROMAGNETIC RADIATION

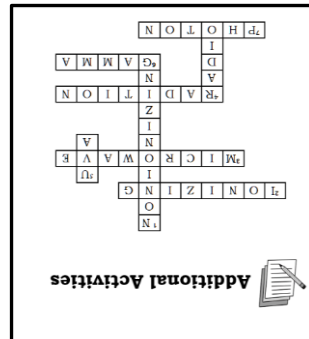
- Ionizing radiation. High energy ultraviolet ray, X-ray and gamma ray.
- Non-ionizing radiation. Radio waves, microwaves, infrared. Visible light and low frequency ultraviolet ray.
- Not so harmful. AM/FM mobile is harmful. X-ray. Medical X-rays. Radio waves. Sources is radio waves. Microwaves oven. TV is in microwave. Sunlight is in the ultraviolet band at lower end of the electromagnetic spectrum. Harmful to the environment.

What's More

What I Have Learned

Assessment

1. Red radiation
2. Green radiation
3. Yellow radiation
4. Blue radiation
5. Purple radiation
6. Orange radiation
7. Pink radiation
8. Brown radiation
9. Grey radiation
10. Black radiation



What's New

What I Have Learned

Assessment

1. Red radiation
2. Green radiation
3. Yellow radiation
4. Blue radiation
5. Purple radiation
6. Orange radiation
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10. Black radiation

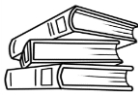
What's More

What I Have Learned

Assessment

1. Red radiation
2. Green radiation
3. Yellow radiation
4. Blue radiation
5. Purple radiation
6. Orange radiation
7. Pink radiation
8. Brown radiation
9. Grey radiation
10. Black radiation

LESSON 2



References

Macalalad, Ernest Pagaran and Vergara, Rhonalyn Ligas 2011. Exploring the Realms of Science Physics. JO-ES Publishing House Inc.

Kaur, Gurpreet and Singh, Jandeep (February 20,2019). Effects of Radiation on the Environment. Retrieved from <https://link.springer.com/book/10.1007/978-3-030-05770-1>

U.S. Department of Health and Human Services Radiation Emergency Medical Management (April 21, 2020). Retrieved from <https://www.remm.nlm.gov/radiationspectrum.htm>

REMM (2020) Electromagnetic Radiation: Ionizing and Non-ionizing. Retrieved from https://www.osha.gov/SLTC/radiation_nonionizing/index.html#additional_resources



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