

Department of Education

Science 10

Effects of Electromagnetic Radiation on Living Things and the Environment Second Quarter - Week 5



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EXPECTATIONS

After doing this Self Learning Module, you are expected to understand the risk and hazards of Electromagnetic (EM) Radiation.

Most Essential Learning Competency:

Explain the effects of EM radiation on living things and the environment.

Objectives:

1. Classify EM waves as ionizing and non-ionizing radiation using the energy levels.
2. Explain the effects of EM waves applications on living things and the environment.
3. Evaluate the risks and benefits derived from the applications of EM waves
4. Explain the principle of EM radiation safety and its importance in society.



PRE-TEST

Directions: Encircle the letter of the CORRECT answer.

1. Which of these types of electromagnetic radiation has the longest wavelength?
A. Radio wave B. Infrared C. Ultraviolet rays D. Gamma ray
2. What term refers to the process of emitting energy through space?
A. Conduction B. Convection C. Exposure D. Radiation
3. Which of the following forms of the electromagnetic wave can ionize living cells?
A. Radio waves B. Microwaves C. Infrared rays D. Gamma rays
4. Which of the following is **not** the ionizing form of electromagnetic wave?
A. Visible light B. Ultraviolet ray C. X-ray D. Gamma ray
5. Which of the following is the effect of a high ionizing electromagnetic wave in living developing cells?
A. Infertility B. Mutation C. Reproduction C. Respiration
6. Which of the following **correctly** describes the relationship of EM Wave frequency to ionizing radiation?
A. The lower the frequency, the higher the ionizing energy.
B. The higher the frequency, the higher the ionizing energy.
C. The higher the frequency, the lower the ionizing energy.
D. The amount of frequency does not affect the ionizing energy.
7. What EM wave can be used to sterilize food and to detect counterfeit bills?
A. Radiowave B. Microwave C. Ultraviolet D. Gamma rays

8. Which of the following is the correct arrangement of electromagnetic waves according to decreasing severity of effect?
- Gamma, radio, microwave
 - Ultraviolet, X-ray, Gamma
 - X-Ray, Ultraviolet, Gamma
 - Gamma, Visible Light, Radio Wave
9. All of the following can ionize atoms and molecules **EXCEPT** ____.
- Microwave
 - Ultraviolet ray
 - X-ray
 - Gamma ray
10. Which type of EM Wave does your body emit most strongly?
- Radio wave
 - Infrared ray
 - Visible light
 - Ultraviolet ray
11. Which of the following **does not** belong in the electromagnetic spectrum?
- Radio waves
 - Sound
 - Ultraviolet ray
 - Visible light
12. The following are common sources of EM waves EXCEPT ____.
- Radioactive Waste
 - Sun
 - Water
 - X-ray machine
13. What type of electromagnetic is used by cellular phones?
- Radio wave
 - Microwave
 - Infrared
 - Visible light
14. Exposure to radiation can be reduced. The following are possible ways to avoid too much exposure EXCEPT ____.
- excessive contact to sunlight
 - increase distance
 - minimizing time of exposure
 - use shielding
15. Which of the following is mismatched?
- Gamma Rays : Cancer & Mutation
 - Infrared Rays: Skin Burn
 - Radio Waves : Internal Heating of Body Tissues
 - Ultraviolet Rays : Blindness



LOOKING BACK

Directions: Arrange the jumbled letters in column A and match to the description in column B.

- | A | B |
|--|--|
| 1) I V L S I B E G H T L I
— — — — — — — — — — | A. It is used in satellite communications, radar, and transmission and cooking. |
| 2) A R I D O W S V A E
— — — — — — — — — — | B. It is the shortest in wavelength and highest in frequency. It can also be used to treat cancer |
| 3) U A I V L L E T R O T
D A I I O T N R A
— — — — —
— — — — — | C. It was discovered by Wilhem Conrad Roentgen in 1895 which helped doctors to look inside the body in diagnosing bone fractures and tumors. |

4)

D R F N I R E A

— — — — —

D. It is the longest wavelength in electromagnetic spectrum which can transmit sound and picture information over long distance.

5)

G M M A A S A Y R

— — — — — — — — — —

E. It lies just beyond the violet end of the visible spectrum. Besides, it is used in sterilizing water and identifying fake bank notes.

6)

A X Y R

— — — — —

F. It is the EM waves of wavelengths that range from 4×10^{-7} m to 7×10^{-7} m which are sensitive to our eyes.

7)

A S M C R V E I O W

— — — — — — — — — —

G. It is emitted by all objects. The amount and wavelength of radiation depend on temperature.



BRIEF INTRODUCTION

The effect of Electromagnetic radiation on living organisms depends on how much energy it carries. For example, radio waves have low energy; hence, it is harmless. On the other hand, high-energy radiation can be harmful to living organisms. Furthermore, the lower-energy parts of the electromagnetic spectrum are not as dangerous as the high-energy radiation. Nonetheless, it can still harm any living organisms.

EM radiation is one of many different kinds of radiation that exist in nature. Generally, radiation is known as the process of emitting energy by any of these two carriers: (1) part case of high-energy protons, neutrons, electrons, atoms, and ions; and (2) waves, either light or sound. One of the common examples of radiation is sunlight. Therefore, we can conclude that radiation is all around us. EM radiation is typically grouped into one of two categories by their frequency:

Non-ionizing: low-level radiation which is generally perceived as harmless to humans

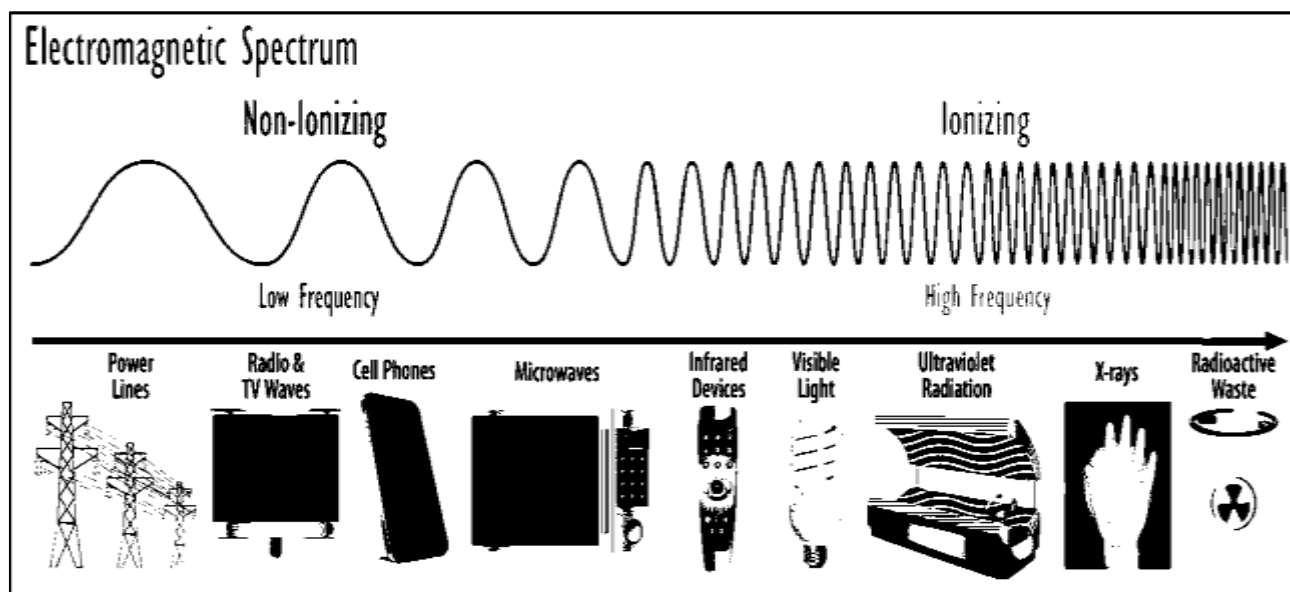
Ionizing: high-level radiation which has the potential for cellular and DNA damage

Ionizing radiation is a damaging form of radiation that can create electrically-charged ions in the materials it strikes. The ionization process can break apart atoms and molecules, causing severe damage in living organisms, either by affecting living tissue directly. As a result, it can lead to sickness, possibly, cancer, or by promoting changes in the DNA known as mutation.



ACTIVITIES

A. Analyze the illustrations then answer the questions below.



<https://www.niehs.nih.gov/health/topics/agents/emf/index.cfm>

Guide Questions:

1. Which are non-ionizing electromagnetic waves? _____
2. Which are ionizing electromagnetic waves? _____
3. Which electromagnetic wave has the highest ionizing radiation? _____
4. Which electromagnetic wave has the lowest ionizing radiation? _____
5. What can you infer to the relationship of EM wavelength and frequency to the ionizing radiation of EM spectrum? _____

B. Complete the table below by using the information stated in the introduction and electromagnetic spectrum illustration.

Radiation Type	Definition	Forms of Radiation	Source Example
Non Ionizing			
Ionizing			

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C. Directions: Fill in the missing word to complete the sentence. Choose your answer below.

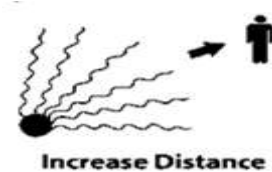
distance	radiation	barriers	radioactive	reduces
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Protecting Yourself to Radiation by Reducing Exposure.

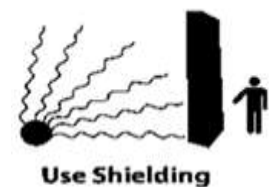
Adapted from <https://www.epa.gov/radiation/protecting-yourself-radiation#self>



Time: For people who are exposed to (1)_____ in addition to natural background radiation, limiting or minimizing the exposure time (2)_____ the dose from the radiation source.



Distance: Just as the heat from a fire reduces as you move further away, the dose of radiation decreases dramatically as you increase your (3)_____ from the source.



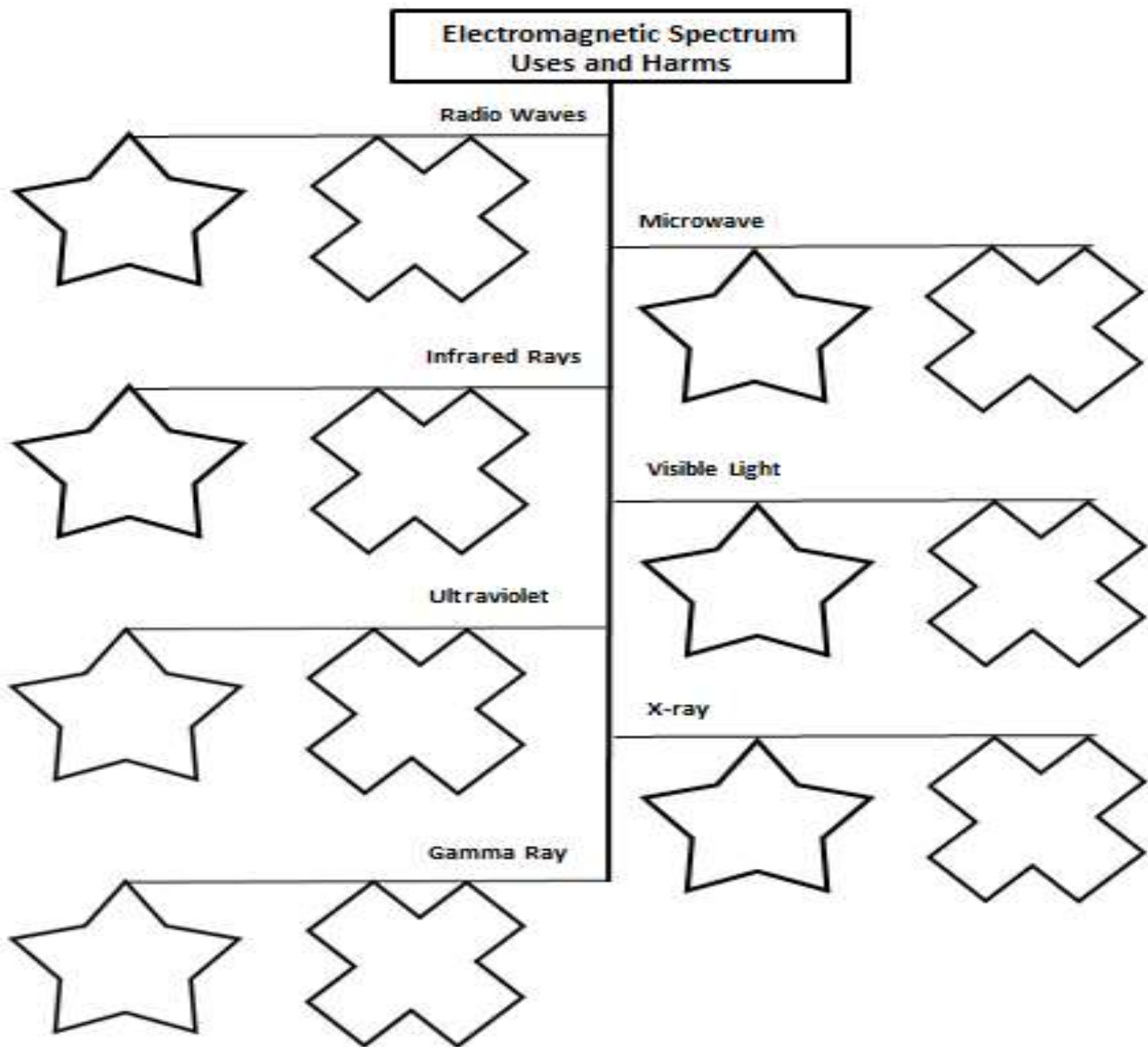
Shielding: (4)_____ of lead, concrete, or water provide protection from penetrating gamma rays and x-rays. This is why certain (5)_____ materials are stored under water or in concrete or lead-lined rooms, and why dentists place a lead blanket on patients receiving x-rays of their teeth. Therefore, inserting the proper shield between you and a radiation source will greatly reduce or eliminate the dose you receive.



REMEMBER

Directions: Listed are some benefits and risks of EM waves. Write the Uses in star shape while Cross for its harmful effect .

1. Broadcasting and Communication
2. Cancer and Mutation
3. Observation of Internal Structures of Objects and Material & Medical Application
4. Skin Burns
5. Cooking, Satellite Transmission, Mobile Phone
6. Cancer
7. Damage to surface cells and blindness
8. Fluorescent Lamp
9. High exposure may result to cataract
10. Internal Heating of body tissues
11. Optical fibres and photography
12. Heaters & Night Vision equipment
13. Medical equipment & Sterilizing food



CHECK YOUR UNDERSTANDING

Directions: Read and analyze the article below. Then, answer the questions found in the last paragraph of the article.

Science, Technology, and Society Is ELF Radiation Dangerous?

We live in fear of the unsensed. Anything that exists, or is imagined to exist, yet escapes detection by our five senses, is often a source of fear.

Many people fear radiation. Some are hazardous, and some are not. No one doubts the hazards of radiation from some nuclear reactions, and no one seriously fears the low-frequency radiations of AM radio. But in recent years a series of books and magazine articles have fanned the flames of public fear by claiming that the extremely low frequency (ELF) radiation of common 60-Hz electric power causes certain forms of cancer.

Is this claim true? Some activists say yes, while most scientists rate it as one of many health scares that prove to be without basis when carefully studied. Bioscientists point out that the electric fields due to power lines at the location of a cell in the body are thousands of times smaller than those due to the normal electric activity of nearby cells. They also point out that cancer rates have remained constant or fallen over the last 50 years (with the exception of rising cancer rates due to smoking). Yet during this time, exposure to ELF radiation has increased tremendously. More detailed analysis of the studies that prompted the controversy show no link between ELF and cancer.

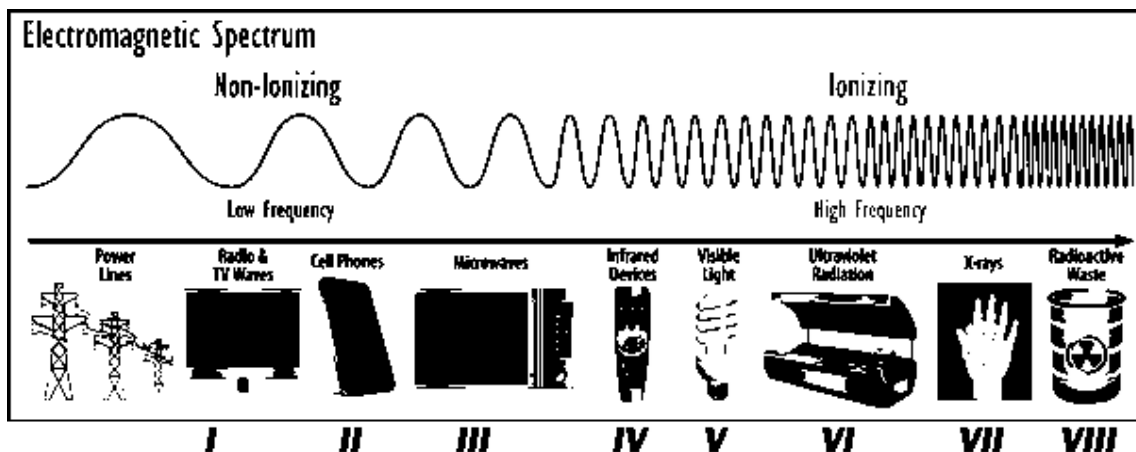
Suppose you're a scientist and you find uncertain evidence that some common food—tomatoes, for example—may be a serious health risk. **What responsibility would you have to make your findings known to the general public? If you stress the uncertainty of your findings, perhaps no one will listen. Should you then make sensational claims, even unsupported, to get people's attention?**

Adapted from Hewitt, Paul G., Conceptual Physics Third Edition, Adison-Wesley Publishing Company, 1997, pp 591



POST TEST

Directions: Read each item carefully. Encircle the letter of the CORRECT answer. For items 1-5 refer to the illustration below:



1. Which of the following groups of EM waves emits high radiation that can break atoms and molecules and can cause severe effect to living cells?
 A. I, II, III B. I, V, VIII C. IV, V, VI D. VI, VII, VIII
2. Which of the the following is used in medical field in observing internal structure of the human body but too much exposure on it can cause cancer?
 A. V B. VI C. VII D. VII
3. Mutation is a change of DNA sequence in cells due to extreme exposure to ionizing radiation. Which of the following can cause mutation?
 A. I B. III C. IV D. VIII
4. Which of the following is an EM wave emitted by all objects in the form of heat?
 A. I B. II C. III D. IV
5. Which of the following is the correct relationship between ionization energy and frequency of Electromagnetic wave?
 A. As the frequency increases, the ionizing energy decreases.
 B. As the frequency increases, the ionizing energy increases.
 C. As the frequency decreases, the ionizing energy increases.
 D. All EM waves have the same amount of ionizing energy.
6. Which has the SHORTEST wavelength and, therefore, has the highest frequency/most energy?
 A. Radiowave B. Infrared C. X-Rays D. Gamma Rays
7. If you're moving from gamma rays to radiowave, describe how the energy level changes
 A. Decreases C. Energy level doesn't change
 B. Increases D. Both A & B
8. Which of the following is the difference between ionizing and non-ionizing radiation?
 A. Non-ionizing radiation is a naturally occurring phenomenon, and ionizing radiation is only created artificially.
 B. Non-ionizing radiation can break apart atoms and molecules, but ionizing radiation does not.
 C. Ionizing radiation can break apart atoms and molecules, but non-ionizing does not.
 D. Ionizing radiation is a naturally occurring phenomenon, and non-ionizing radiation is only created artificially.
9. Limiting or minimizing the time of exposure from the source of radiation ____.
 A. will reduce the amount of radiation received
 B. will increase the amount of radiation received
 C. will not change the amount of radiation received
 D. will result in the need of a slower speed film
10. When radiation interacts with living tissues, _____.
 A. the cells become energized
 B. the radiation shifts to a different waveform
 C. the cells becomes radioactive
 D. the cells either die or become a different kind of cell such as a cancer cell

11. Television Station like GMA 7 transmits signals through wave frequency. Which of the following is used by the network for broadcasting and communication?
 A. Radio Wave B. Microwave C. Infrared D. Visible Light
12. What causes a radio wave to emit non-ionizing radiation?
 A. Short Wavelength C. Low Frequency
 B. Varying Frequency D. High Frequency
13. What EM Wave is used for satellite transmission?
 A. Radiowave B. Microwave C. Ultraviolet D. Gamma Rays
14. What element is used as a shield to provide protection from penetrating x-rays and gamma rays?
 A. Lead B. Platinum C. Silver D. Tin
15. Evaluate the statements below:
 1st: Limiting or minimizing the exposure time reduces the dose from the radiation source.
 2nd: The dose of radiation decreases dramatically as you decrease your distance from the source.
- A. 1st is True; 2nd is False C. 1st is False; 2nd is True
 B. Both are false D. Both are True



Answer Key

Pre-Test		Activities		Looking Back	
1. A	1. Radio wave	1. A	1. Radio wave	1. F - VISIBLE LIGHT	1. F - VISIBLE LIGHT
2. D	2. Microwave	2. B	2. Microwave	2. D - RADIO WAVES	2. D - RADIO WAVES
3. D	3. Infrared	3. B	3. Infrared	3. E - ULTRAVIOLET RADIATION	3. E - ULTRAVIOLET RADIATION
4. A	4. Visible Light	4. B	4. Visible Light	4. G - INFRARED	4. G - INFRARED
5. B	5. Ultraviolet	5. C	5. Ultraviolet	5. B - GAMMA RAYS	5. B - GAMMA RAYS
6. B	6. X-ray	6. D	6. X-ray	6. C - X-RAY	6. C - X-RAY
7. C	7. Gamma Ray	7. A	7. Gamma Ray /	7. A - MICROWAVES	7. A - MICROWAVES
8. D	8. Gamma Ray				
9. A	9. Radioactive				
10. B	10. Waste				
11. B	11. The higher the				
12. C	12. frequency the				
13. B	13. higher the				
14. B	14. ionizing				
15. C	15. energy.				

Remember		Post Test	
EM Wave	Uses	Harmful effect	1. D
Radio Wave	Broadcasting and Communication	none	2. C
Microwave	Cooking, Satellite Transmission, Mobile Phone	Internal Heating of body tissues	3. D
Infrared	Heaters & Night Vision equipment	Skin Burns	4. D
Visible Light	Optical fibers and photography	High exposure may result to cataract	5. B
Ultraviolet	Fluorescent lamp	Damage to surface cells and blindness	6. D
X-ray	Observation of Internal Structures of Objects and Medical Application	Cancer	7. A
Gamma Ray	Medical equipment & Sterilizing food	Cancer & Mutation	8. C
			9. A
			10. D
			11. A
			12. C
			13. B
			14. A
			15. A

B		C.	
Radiation Type	low-level radiation which is generally perceived as harmless to humans	Radio wave	Radio & TV Wave,
Definition	high-level radiation which has the potential for cellular and DNA damage	X-ray	cellphone, Microwave oven, Infrared device, Sunlight,
		Ultraviolet	Light bulb
		X-ray	X-ray machine,
			radioactive Waste

1. Radiation		2. Reduces		3. Distance		4. Barriers		5. Radioactive	
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Reference

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Aquino, Marites D., Valdoz, Meliza P., Biong, Jonna A., Andaya, Mylene O., Science Links 10, Rex Book Store, 2015, pp. 110-115

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<https://www.niehs.nih.gov/health/topics/agents/emf/index.cfm>

<https://www.epa.gov/radiation/protecting-yourself-radiation#self>