Electromagnetic Wave Basics

Before diving into your study of electromagnetic waves, it is important that you know all of the following material. Much of this was covered in previous units, but it is such foundational knowledge, it never hurts to go over it more than once.

Crucial Facts on Electromagnetic Waves:
A *wave* is moving energy in the form of a moving oscillation.
An *electromagnetic wave* consists of oscillating electric and magnetic energy.
All electromagnetic waves are *transverse waves*.
In physics, a *vacuum* is a space with no matter. We do not live inside a vacuum, because we are surrounded by air, which is matter. You can create a vacuum on earth by sucking the air out of a small scape using a *vacuum pump*. However, the most important vacuum to know about is *outer space*. Because there is very very little matter between the stars and planets, outer space is near perfect vacuum.
Electromagnetic waves all move at the speed of 3.0 x 10^8 m/s in a vacuum.
Electromagnetic waves can move through some matter as well.
For example, a radio wave can move through most matter, which is why you can use your radio indoors.
A visible light wave can move through air or glass, but cannot move through steel.
All electromagnetic waves are capable of moving through a vacuum. This is why:
- you can see the stars, the other planets, and moon.
- Sun sends light and heat to the earth

Electromagnetic waves are often contrasted with mechanical waves.
- Mechanical waves are waves of oscillating matter.
- Mechanical waves exist only in matter and thus can never move through a vacuum
- All mechanical waves move at different speeds, but all of these are much much slower than the speed of light 3.0 x 10^8 m/s.
- Mechanical waves can be either transverse or longitudinal.
All electromagnetic waves come in tiny pieces called **photons**.
The most important example of an electromagnetic wave is LIGHT.
However, there are seven types of electromagnetic wave in total: visible light and six others which are invisible:
Radio Waves
Microwaves
Infrared Waves
Visible Light Waves
Ultraviolet Waves
X-Ray Waves
Gamma Ray Waves
Always remember the electromagnetic waves in this order, because this is the order from longest wavelength to shortest wavelength.
It is easy to remember them using this mnemonic device:
Raging Martians Invade Venus Using X-Ray Guns

Questions and practice:

True or False:

1. Mechanical waves move faster than electromagnetic waves.

2. Mechanical waves can move through a vacuum.

3. Electromagnetic waves can move through a vacuum.

4. Electromagnetic waves are always transverse.

5. Electromagnetic waves can be transverse or longitudinal.

6. There are seven types of electromagnetic waves.

7. Electromagnetic waves are made of oscillating electric and magnetic energy.

8. As you read this page, Raging Martians are Invading Venus Using X-ray Guns.

9. Copy the seven types of electromagnetic waves twice. Yes, it's repetitive, but a little bit of copying does help you remember things.

Fill in the blanks of the following paragraph using items from the word bank. Each word is used once.

Word Bank

3.0 x 10^8 m/s
Electric
Vacuum
Transverse
Photons
Visible
Faster
Invisible
Magnetic

An electromagnetic wave is a type of wave consisting of oscillating (10)_____ and (11)_____ energy. Electromagnetic waves always come in tiny little pieces called (12)_____, and all electromagnetic waves move at a speed of (13)_____. Electromagnetic waves are different from another type of wave, called a mechanical wave.

Electromagnetic waves are capable of moving through a (14)_____, while mechanical waves are not. Electromagnetic waves are all (15)_____ waves, while mechanical waves can be either transverse or longitudinal waves. Electromagnetic waves all move much much (16)_____ than mechanical waves. There are seven different types of electromagnetic wave. One of these types is (17)_____ light, while the other six are all (18)_____.

19. You can *see* the sun but you cannot *hear* the sun. And the sun is making lots and lots of noise, as much as thousands of atomic bombs exploding every second. Explain why you can see the sun but not hear it.

20. By using the concepts and vocabulary on this page, explain why you see lightning before you hear thunder.

Answers

1. False
2. False
3. True
4. True
5. False
6. True
7. True
8. Probably false, but this is still a good way to remember the seven types of electromagnetic waves!
9. Radio micro infrared visible light ultraviolet X-Ray gamma ray.
   Radio micro infrared visible light ultraviolet X-Ray gamma ray
10. Electric
11. Magnetic
12. Photons
13. 3.0 x 10^8 m/s
14. Vacuum
15. Transverse
16. Faster
17. Visible
18. Invisible
19. The light waves that the sun creates are electromagnetic and can move through the vacuum of space. The sound waves that the sun creates are mechanical and cannot move through a vacuum.
20. When electrons jump to earth, they create light and sound. The light waves are electromagnetic and the sound waves are mechanical. The sound waves move fast, but the light waves move much much much faster. Therefore, you see the lightning almost instantaneously, but you hear the thunder seconds after.