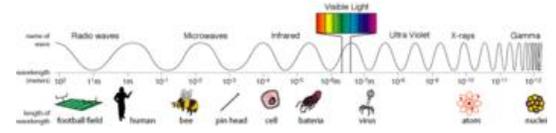


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The Electromagnetic Spectrum

Look around you. What do you see? You might say "people, desks, and papers." What you really see is light bouncing off people, desks, and papers. You can only see objects if they reflect light (or produce it).



Think about it- if the room were in total darkness, would you still be able to see the people, desks, and papers? No.

We see light as brightness or the opposite of darkness. Light is a type of energy made by the vibration of electrically charged particles. What we call light is just part of this energy. Scientists call light electromagnetic radiation. Some sources of light are the sun, other stars, and fire. We can feel heat from the sun and fire. We can't feel the heat from stars because they are too far away, but they do make heat just as our sun, also a star, does. Light transfers energy in the forms of light and heat. Light transfers energy in other forms that are harder to detect.

The sun produces a huge amount of energy. The energy the sun produces travels in little particles called photons. There are different kinds of energy produced by the sun. Some light we can see, just a tiny part of it, called visible light. Other types of light energy are invisible. There are different wavelengths of light, or really, we should call it electromagnetic radiation or EM for short. Other types of EM are very long radio waves and very short wavelengths like x-rays and gamma rays. Electromagnetic energy doesn't need matter to travel through. That's a good thing for us! Because there's not much matter in space, we wouldn't get energy from the sun if light needed to travel through matter.

Energy travels from the sun in photons that move in waves. Each wave contains many different kinds of light; some we can see, and some we cannot. All light- visible and invisible- is part of the electromagnetic spectrum. Every kind of light travels in waves, like ripples in a pond or like ocean waves. A light's wavelength determines whether we can see it or not, and it determines what color we see. Light waves carry both electric and magnetic energy. Gamma, x-rays, ultraviolet (UV), visible, infrared, microwaves, and radio waves are all the forms of EM. This is called the electromagnetic spectrum.

The longer the wavelength, the less energy the EM carries. Visible light is just a very small portion of electromagnetic energy. Visible light comes in these colors: violet, indigo, blue, green, yellow, orange, and red. Red has the longest wavelength of visible light, so it has the lowest energy. Violet light has the shortest wavelength, and so it has the highest level of energy of visible light. Radio waves have the longest wavelength and the lowest level of energy. Gamma rays have the shortest wavelength and the highest level of energy of the EM spectrum.

Sunlight appears white. We can separate the colors by bending the light rays with a prism. Your shirt, for instance, absorbs almost all the colors in white light - except for one color that it reflects. It is this color that we see. If your shirt is red, it absorbs all the other colors. It soaks them up like a sponge soaks up water. Except for red. A red shirt reflects red light rays back to our eyes so the color red is what we see. A black object looks black because it

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absorbs all colors of light and reflects none of them. White objects look white because it reflects all colors and absorbs none.

Isaac Newton was the first scientist to discover the connections between color and light. In the 1600s, he passed a beam of sunlight through a prism. A prism is a three-sided piece of glass. When light passes through a prism, it must bend because of the angle of the glass. He saw how the light was divided into different colored rays. When he passed the colored rays through another prism, he saw that they turned back into white light. When we see a rainbow, water droplets in the sky make the light bend just like a prism does. Because the different colors travel at different speeds, when they bend they are separated into different colors. That's why we can only see a rainbow at certain times of the day. It depends on the angle between us, the sun, and the water droplets in the sky.

Scientists think that all light moves at the same speed in a vacuum. The speed of light in a vacuum is about 300,000,000 meters per second, or about 186,000 miles per second. It takes light about eight minutes to travel from the sun to Earth. It would take light about 100,000 years to move from one side of the Milky Way Galaxy to the other. Scientists use this measurement of light to describe distances in space. The distance that light travels in one year is a unit of distance called a light-year. So, the Milky Way Galaxy is about 100,000 light-years across. These two measurements are light traveling through a vacuum. Light slows down when it moves through something like Earth's atmosphere or water.

Light always travels in straight lines. When it passes from one medium to another (from air into water, for example), light changes direction slightly. This is called refraction. Refraction happens because light travels at different speeds through different materials or mediums. Light travels faster through air than it does through water. You can see this for yourself. Fill a glass three-fourths full with water. Then put a pencil in the glass. The pencil should be long enough to stick up out of the water. When you look at it, it looks like the pencil is broken at the water line!

The sky looks blue to us because light rays get scattered as they pass through Earth's atmosphere. Energy that is scattered causes a change in direction of the light path. While all colors are scattered by air molecules, violet and blue are scattered most. This is because of their shorter wavelengths and higher energy. The sky looks blue, not violet, because our eyes are more sensitive to blue light. The sun also emits more energy as blue light than as violet.

At sunset and sunrise, sunlight passes through more atmosphere than during the day when the sun is higher in the sky. More atmosphere means there are more molecules to scatter the violet and blue light. If the path is long enough, all of the blue and violet light is redirected out of your line of sight, while much of the yellow, orange, and red colors continue along the path between your eyes and the sun. This is why sunsets and sunrises often have yellow, orange, and red colors.

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The Electromagnetic Spectrum

Questions

- _____ 1. We see light because:
- A. Our eyes are sensitive to it.
 - B. Objects absorb it.
 - C. Objects reflect it.
2. Name some sources of light.
- _____ 3. Light is energy made by:
- A. the sun
 - B. the vibration of electrically charged particles
 - C. both of these
 - D. none of the above
- _____ 4. Light, like sound waves, needs matter to travel through.
- A. true
 - B. false
- _____ 5. We can see all the energy given off by the sun with our eyes.
- A. true
 - B. false
- _____ 6. Besides visible light, name some other types of waves in the electromagnetic spectrum.
- A. X-rays
 - B. radio waves
 - C. microwaves
 - D. infrared
 - E. all of the above
- _____ 7. The longer the wavelength, the less energy the EM carries.
- A. false
 - B. true
- _____ 8. What kind of rays has the highest amount of energy in the EM spectrum?
- A. infrared
 - B. gamma rays
 - C. X-rays
 - D. ultraviolet rays
- _____ 9. Why does an apple look red to us?
- A. The apple absorbs all other colors of light, but it reflects red.
 - B. The apple reflects all other colors of light, but it absorbs red.
 - C. The apple looks red because it reflects infrared waves.

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- _____ 10. How long does it take for light from the sun to reach Earth?
- A. eight seconds
 - B. eight hours
 - C. eight minutes
- _____ 11. What is refraction?
- A. when light changes direction as it passes from one medium into another
 - B. when a pencil in a glass of water looks broken
 - C. both of these
- _____ 12. What causes refraction?
- A. when light travels at different speeds through different materials
 - B. a reflection of light
 - C. a mirror

