Reading 13.1 – Nonvisible Light

Getting Ready

Imagine that your remote control used visible instead of nonvisible light. Would this be a good idea? Why?

Today, you will read more about nonvisible light. You probably do not realize it, but nonvisible light plays an important role in your life every single day! By the end of this reading, you should be able to describe how radios, cell phones, microwave ovens, or x-rays machines use nonvisible light. By explaining even one of those to someone who is not in your class, you can help them understand something interesting. And you will help yourself understand nonvisible light even better by explaining it to someone else!

How Does Light Travel?

In class, you learned that light travels in a similar way to waves moving across water. You saw that when water waves move in a pan of water, the ripples can be spaced very close together (having a small wavelength) or very far apart (having a large wavelength).

Light can also travel with a wavelength that is very small or very large. But your eyes can only detect light if its wavelength is within a certain range. Human eyes can only detect light with a wavelength between 400 and 700 nanometers. A nanometer is one billion times smaller than a meter. How small is that? A single hair on your head is about 80,000 nanometers wide. This means that the wavelength of visible light is more than a hundred times smaller than the width of your hair! Try to think about this before you keep reading. You may need to read through this description again to really understand how small the range of light is that your eye can see. It is amazing!

How Much Nonvisible Light Is There?

Infrared light has a wavelength that is a little greater than 700 nanometers. Therefore, you cannot see it. Ultraviolet light has a wavelength that is a little less than 400 nanometers.

Wavelength < 400 nanometers = nonvisible (UV)

Wavelength between 400–700 nanometers = visible

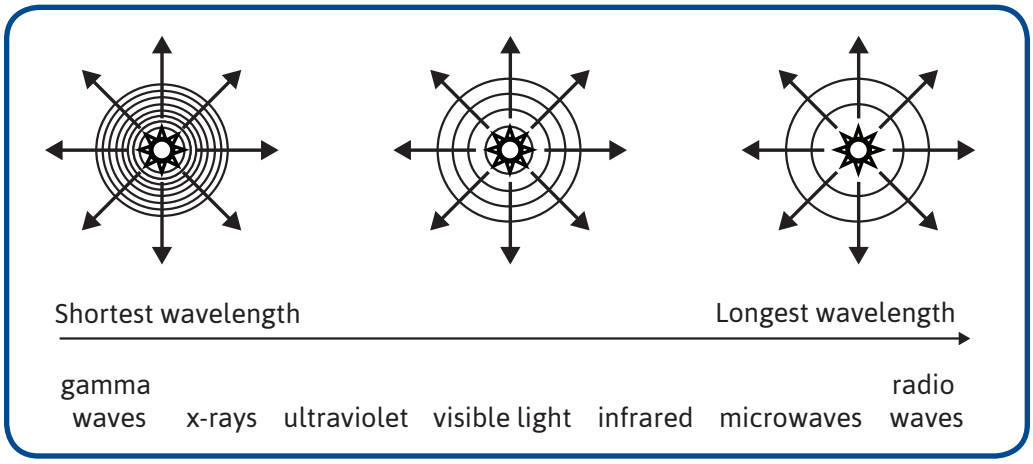
Wavelength > 700 nanometers = nonvisible (IR)

Even though the wavelengths of infrared and ultraviolet light can be close to the wavelengths that your eyes can detect, your eyes still cannot detect them.

Nonvisible light can have a wavelength millions of times smaller than a human hair or bigger than the entire Earth! Because nonvisible light can have so many different wavelengths,

scientists created a system to keep track of them. In this system, scientists have divided all of the possible wavelengths into categories. You have probably heard of some of the categories, because many of the devices you use every day operate using nonvisible light.

The longest wavelengths of light are called *radio waves*. Find them on the following chart. The shortest wavelengths are called *gamma waves*. Find them on the chart. In between are microwaves, x-rays, infrared light, ultraviolet light, and visible light.



There is a lot of light in the world. Some of it is visible. Some of it is nonvisible. Do you think that most of the light that hits your eye is light that you can see or not? Explain your answer. (The previous chart should help you.)

Although you cannot see nonvisible light, your body can detect it in other ways. Infrared light makes you feel warm. When you go out into the sunlight, your skin absorbs infrared light. You cannot see that light, but you can feel it as warmth. Your skin also absorbs visible light and ultraviolet light when you are in the sun. In class, you learned that the ultraviolet light from the sun can give you sunburn. Even though you cannot see it, nonvisible light from the sun is very important for making Earth a warm, comfortable place to live.

Some Ways We Use Nonvisible Light

Many of the devices that you use every day rely on light that your eyes cannot detect. Do you ever listen to a radio? Radios are designed to detect radio waves. Radio waves are a type of nonvisible wave given off by an antenna at a radio station. Just like your eye detects light and sends a signal to your brain, a radio antenna detects radio waves and sends a signal to your speakers. The radio speakers then produce a sound that you can hear.

Radio waves have the longest wavelength of any kind of light. Their wavelength can be many kilometers long.

Even before reading today, you probably know something about microwaves. A microwave oven uses microwave light waves. Look back at the chart of types of light to see how microwave light compares to other types.

Years ago, scientists discovered that water easily absorbs microwave light. When microwaves are absorbed by water, the temperature of the water increases. This is useful to know because nearly all of the food you eat has some water in it. When you put your food in a microwave oven, the water in that food absorbs nonvisible microwave light and heats up. The heated water then heats the food around it, which makes your food hot.

Look at this photo. When someone takes food out of the microwave oven, the food is hot but the container the food is in may still be quite cool. Why do you think a microwave oven can heat food without heating the bowl?

Microwaves are also useful for sending signals. Here is something you probably did not know: When you talk on a cell phone, your phone is actually sending and receiving microwaves!

Using X-rays to See through Things

While long wavelengths of light are useful for sending signals over large distances, shorter wavelengths of light are useful for other purposes. X-rays and gamma rays make it possible for people to see through things. Have you ever broken a bone? If so, a doctor probably used an x-ray machine to take a picture of your bones.

Using an x-ray light source, doctors send x-rays through your body toward special photographic film on the other side. When x-rays strike the film, they are absorbed and turn the film black. Bones show up white on an x-ray because these are the areas of the film where very few x-rays are absorbed by the film.

If a person wears a metal ring while they have an x-ray, the ring will appear bright white. The photo on the right shows this. Now that you understand more about light, absorption, and transmission, you can probably explain this. Does metal mostly *transmit* or *absorb* x-rays? Explain your answer.

X-rays at the Airport

X-rays are useful for airport security workers, who check passengers' luggage for dangerous materials. By using x-rays, they can look inside luggage without opening it. When you fly on a plane, workers shine x-rays on your luggage. The picture to the right shows what they see. You may notice that the objects in this picture show up as different colors. An airport x-ray machine works a little differently than a doctor's x-ray machine. The objects do not look like bones, do they?

All x-rays have a wavelength of about a single nanometer, but they can be a little bigger or smaller. A medical x-ray machine only uses one wavelength of x-rays, but an airport machine uses many different wavelengths. Since different materials absorb different wavelengths of x-rays, workers can tell what kinds of materials are inside of bags. This helps them to know whether something is made of metal, rubber, or cloth. Is that not amazing? They never even have to open your bag to know what is inside!

However, x-rays can be damaging if a person is exposed to them too often. Medical people wear metal aprons made of lead, or they stand behind a lead wall when they take x-rays. Why would a dark-colored cloth not work as well as lead?

In this unit, you have learned a lot about light. You learned that light must enter your eye in order for you to see. You learned that there are many wavelengths of light that your eye cannot detect. Even though you cannot see it, you use nonvisible light every day. It makes you warm, helps you communicate, heats your food, and can even help you see through things!