

# Making Waves at Swim Practice

You're sitting with the rest of the swim team, waiting for practice to start. Everybody's on a long metal bench next to the pool. Suddenly, you hear banging over and over, and it's really annoying. You look around, and realize a teammate at the other end of the bench is kicking the bench—that's what's making the noise. You get up to go ask them to stop, but as soon as you get off the bench you can barely hear the sound of the kicking anymore. You try sitting back down, and it's just as loud as before. Is your teammate playing a trick on you? Why can you hear the sound when you sit on the bench, but not when you're standing up? It's not a trick—when you're sitting on the bench, that banging sound is actually traveling to you through the metal of the bench. You probably know sound waves can travel through the air, but they can also travel through solid materials like metal. That's because metal and air are both made of matter.

Sound waves can travel through any kind of matter, including water and other liquids. After practice starts and you jump into the pool, you can hear splashing sounds underwater. Sometimes, during free swim time, you and your friends sing and shout words to each other underwater for fun. People sound different underwater than they do in the air, so it's not always easy to understand what a person is saying underwater. That's because sound waves travel a little bit differently in water than they do in the air. Sound waves travel at different speeds in different materials. When sound waves are moving through water, they travel faster than they do through air. Surprisingly, sound waves travel fastest when they are moving through solid materials like the metal of the bench.



Now practice is over, and you and the rest of the team are resting on the edge of the pool, dangling your feet in the water. You notice how weird everybody's feet and legs look through the water. When they're in the water, your legs look ripply and even seem to bend in odd directions, but if you pull them out, they look straight again. It's not your legs that are bending in the water, it's light! Both water and air transmit light, meaning light can pass through them. Light reflects off your legs, traveling through the water and then passing into the air. The light bends as it passes from the water to the air, and the bending light makes your legs look bent. This bending of light is called refraction: light refracts when it passes from one material (such as water, air, glass, or plastic) into another.

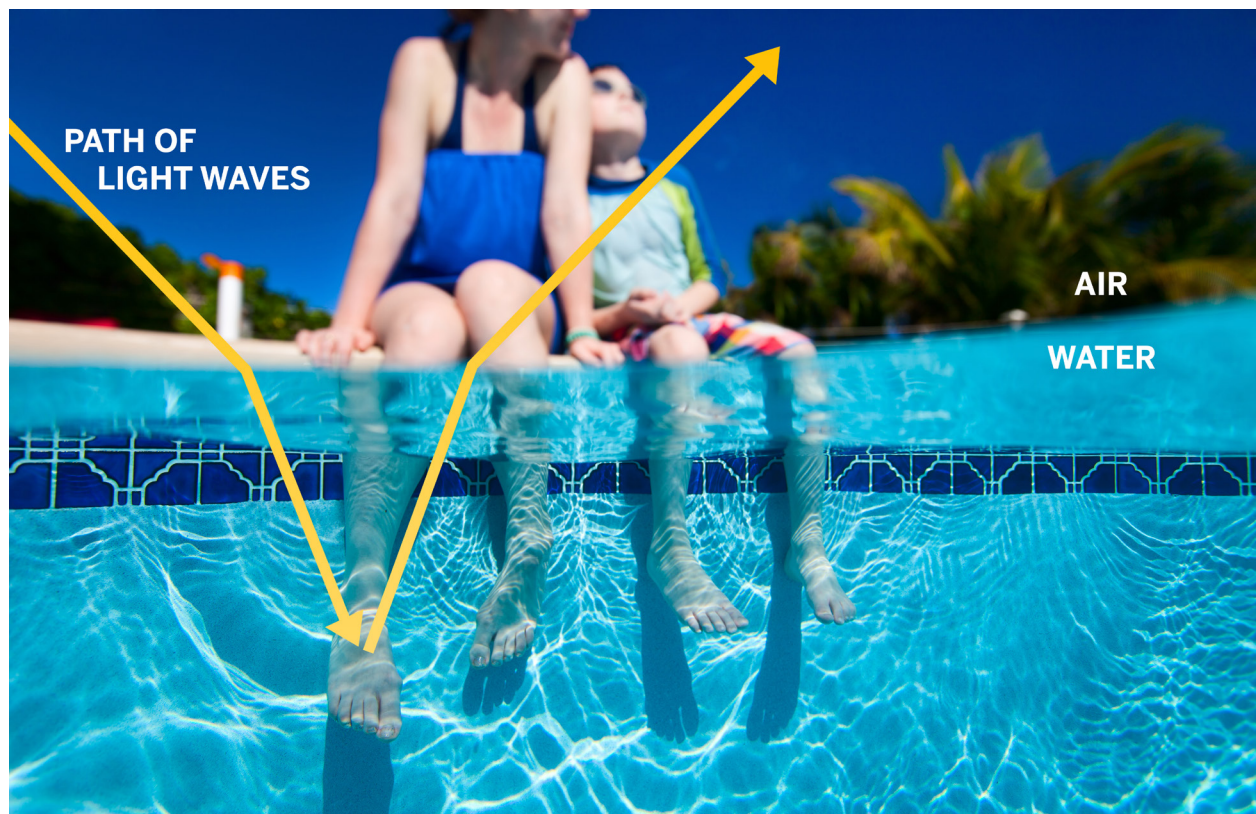
Why does light refract? Just like sound waves, light waves travel at different speeds depending

on what they are traveling through. Light always travels fast, but light waves move fastest when they are traveling through empty space. (Unlike sound waves, light waves can move through empty space—they don't need matter to travel through.) Light waves move a little bit more slowly when they travel through matter, such as the gases that make up air. When traveling through water, light waves move more slowly than they do when they move through air. As the light waves pass from one material to another, they speed up or slow down, and this change in speed makes the light bend.

When light bends, interesting things happen. Have you ever noticed a rainbow in the spray of water droplets from a hose? Rainbows also happen because of refraction. White light (such as sunlight) is actually made up of many different colors of light, and each color has a

different wavelength. For example, blue light has a shorter wavelength than red light. The wavelength of a light wave affects the angle at which it bends when it passes from one material to another. (That's called the angle of refraction.) When sunlight passes from the air into droplets of water, all the different colors in the light refract differently—some bend farther than others because they have different wavelengths. Refraction separates the white light into bands of different colors, and we see a rainbow.

All waves—light waves, sound waves, and every other kind of wave—travel at different speeds in different materials. That affects the way you see and hear everything around you, from an annoying noise to the sparkle of sunshine on the water.



Light waves refract (bend) as they pass from the air to the water. Then they reflect off the leg. The light waves refract again as they pass from the water to the air.