Chapter 2

Energy With a Vision

Waves of Light

Waves of sound and light do more than just move. They can act in strange and mysterious ways. Have you ever seen your reflection in a fun-house mirror? Light bouncing off a fun-house mirror can make you look pretty strange!

Like sound waves that reflect off a wall, light waves can also reflect off a surface. When light strikes an object, some of the light waves are absorbed. Some waves may go through the object. Still other light waves may be reflected from it. When we see something that doesn't give off its own light, our eyes are seeing reflected light waves.

Look at your reflection in a mirror. Did you know you're seeing light waves that have been reflected twice? First, the light reflects off your body. Then that light reflects off the mirror. A flat, shiny surface like a mirror reflects light very precisely. That means light waves bounce off the mirror at exactly the same angle that they struck the mirror. The result is an image that looks much like its source.

Sometimes a shiny surface is not flat but curved, like a fun-house mirror or the back of a spoon. This makes light waves reflect at different angles. The image you'll see won't look exactly like its source because the reflecting surface was curved. The image you see could look very different from the object in front of the curved mirror or spoon.

A curved surface, like a fun-house mirror, makes an image that is different from its source.

A flat surface, like a mirror in a dance studio, makes an image that looks much like its source.

Light Makes It Bright

The sun is the source of most of the light that brightens our world. Light can come from other sources, too. A candle flame produces a soft glowing light. When electricity flows through a light bulb, a thin metal wire inside the bulb heats up. The wire gets so hot that it gives off a bright light.

Even some living things can make their own light through chemical reactions. This neat trick is called **bioluminescence**. Fireflies, for example, store two unique chemicals in their bodies. When the chemicals mix in the presence of oxygen, tiny bursts of light energy are given off. These are the flashes fireflies make as they flit around on warm summer nights.

Whatever its source, light is the fastest thing in the universe. Unlike sound waves, light waves can travel through a vacuum such as outer space. In fact, light waves move the fastest in outer space. This is because there is almost nothing in outer space to slow down light waves. Light waves travel through space at 300,000 kilometers (about 186,000 miles) per second.

We see the objects around us when our eyes detect light waves and our brain makes sense of the signal. We see light waves only within a small range of frequencies.

Firefly

Visible light is light with frequencies that humans can see.

Honeybees can see ultraviolet light, but humans cannot.

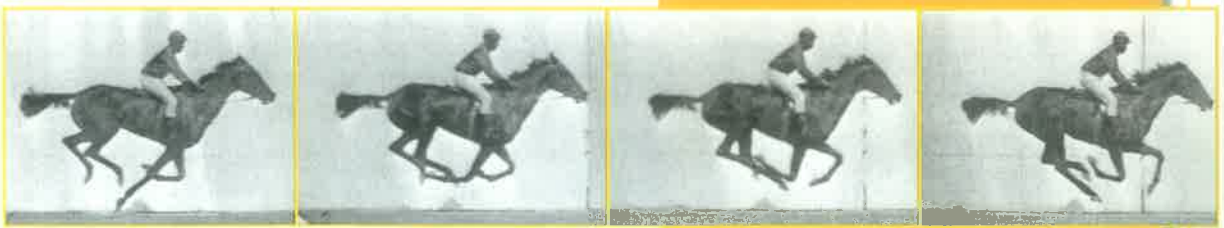
The light waves we can see are called **visible light**. However, there are light waves outside of this range that we cannot see. For example, waves of **ultraviolet light** have a higher frequency than visible light waves. We can't see ultraviolet light, but it can hurt our eyes. However, honeybees and some other animals can see ultraviolet light.

Where do light waves move the fastest?

Focus On ›››

Eadweard Muybridge: Pioneer Moviemaker

In the 1870s, the former governor of California had a debate with his friends. He said that a galloping horse had all of its hooves off the ground at one point in its stride. English photographer Eadweard Muybridge used light and a camera to settle the dispute. Muybridge placed cameras along a racetrack. As the horse galloped by, the cameras were snapped in sequence. The pictures showed that, at one point, all four of the horse's hooves were off the ground. The photos captured the facts in black and white. More important, when Muybridge projected the pictures of the horse on a screen, he made one of the world's first moving pictures!



Colors in Light?

If you stand outside on a bright sunny day, the sunlight you see probably doesn't look very colorful. In 1665 English scientist Isaac Newton did some clever experiments and found color in light by using only sunlight and pieces of glass. In his light experiments, Newton used triangular-shaped blocks of glass called **prisms**. He focused a narrow beam of sunlight on a prism at a certain angle. Then something remarkable happened. The light came out the other side of the prism as a colored band that looked like a miniature rainbow. This spread-out pattern of colors is called a **spectrum**.

In Newton's experiments with sunlight and prisms, it was the **refraction**, or the bending, of light that he was seeing. As sunlight shines through the prism, the colors that make up sunlight are refracted. That means the different colors of light are bent by different amounts. The colors that make up the spectrum are red, orange, yellow, green, blue, indigo, and violet. All of these colors have wavelengths of light that our eyes can see.

If light is made up of many colors, why do some things look green, and others look blue or purple? Well, the color of an object depends on the way that it either reflects or absorbs colors in the light spectrum. For example, a green leaf absorbs all the colors in the spectrum except green. When light hits the leaf, only the color green reflects off the leaf and back to your eye. A black object absorbs all the colors in the spectrum and reflects no light. An object that looks white doesn't absorb any color and reflects all the colors in the spectrum back to your eyes.

Word Power

The word *spectrum* comes from Latin words that mean "appearance" or "ghost." In a rather ghostly way, the colors of the spectrum "hide" in white light. They appear only when the light is bent in a certain way, such as when it passes through a prism.

Thinking Like a Scientist: Defining Operationally

When scientists do experiments, they describe the objects they observe and the events that take place. When a scientist describes an object based on what it does in an experiment, he or she **defines** the object **operationally.** An operational definition is a description of an object based on what the object does or how it works. For example, think about a piece of triangular glass. It could be a decoration, a piece of jewelry, or a Christmas-tree ornament. But if that piece of glass refracts light into the colors of the spectrum, it is a prism. You could make an operational definition of a prism based on your observations of what the piece of glass does to light.

Based on what you know about how a mirror affects light, make an operational definition of a mirror.

When Newton shined light on a prism, the white light was bent into a pattern of colors called a spectrum.