Light

Light, Matter, and Color

Read to Learn

What is light?

Suppose you are touring a cave deep below Earth's surface and the lights go out. Would you see anything? No! You could not see anything because there would be no light for your eyes to sense. **Light** *is electromagnetic radiation that you can see*. Electromagnetic radiation has wave properties and particle properties. A particle of electromagnetic radiation is called a photon. The frequency of a light wave depends on the amount of energy carried by a photon of light. Light waves can carry this energy through space and some matter.

Sources of Light

You can see an object if it is luminous. You also can see objects that are illuminated. Luminous objects, such as a candle or a campfire, release, or emit, light. The Sun is luminous because it is made of hot, glowing gases. A traffic light and a firefly are also luminous objects. Luminous objects are sources of light. You can see objects, such as trees and grass, when they are illuminated. Illuminated objects do not emit light, and they are not sources of light. The Moon might appear bright, but it is just a rocky sphere. You see the Moon because it reflects light from the Sun. *The bouncing of a wave off a surface is* **reflection.** In a dark cave, there is no light to reflect off objects, so you cannot see anything.

How Light Travels

Light travels as waves moving away from a source. Scientists often describe these waves as countless numbers of light rays spreading out in all directions from a source. Shadows form where an object blocks the path of light. Shadows are places with less light. Shadows show that light normally travels in a straight line. However, objects in its path can cause light to change direction. It can spread out slightly as it moves through a small opening.

Light and Matter

What can you see through your classroom window? Would you still be able to see anything if the blinds were closed? How do different types of matter affect light?

You can see objects clearly through air, clean water, plain glass, and some plastics. *A material that allows almost all the light that strikes it to pass through and form a clear image is* **transparent.** Clear window glass is transparent.

Light also passes through frosted glass, but clear images do not form. *A material that allows most of the light that strikes it to pass through and form a blurry image is* **translucent.** Plastics with textured surfaces also are examples of translucent materials.

No light passes through wood and metal objects. *A material through which light does not pass is* **opaque.**

Transmission of Light

You just read that light passes through transparent and translucent objects. *The passage of light through an object is called* **transmission.** You can see objects through the glass in a window because the glass transmits light. A luminous object or an illuminated object on one side of a glass window is visible on the other side of the window. The energy carried by the light waves from these objects can pass through the glass.

Absorption of Light

Imagine standing near a window on a spring day. The transparent window transmits some sunlight, and it lands on you. If you touch the window, it might feel warm. Some of the energy in the Sun's light stays inside the window. *The transfer of energy by a wave to the medium through which it travels is called* **absorption.** The energy causes atoms in the material to vibrate faster, increasing the temperature of the material. All materials absorb some of the light that strikes them. The window feels warm because it absorbs some of the sunlight's energy.

Reflection of Light

When you look at a pane of glass, you can sometimes see an image of yourself. Light bounces off you, strikes the glass, and bounces back to your eye. Recall that the bouncing of a wave off a surface is called reflection.

Think again about the window. With a window, you can observe the transmission and reflection of light. You cannot see it, but some of the light also is absorbed. Most types of matter interact with light in a combination of ways.

Light and Color

Recall that visible light is electromagnetic radiation with wavelengths of all colors of the rainbow. The longest wavelengths of light appear red. Violet has the shortest wavelengths. Other colors of light have different wavelengths. White light is a mixture of all wavelengths of light. How does this account for the colors you see in the world?

Colors you see result from wavelengths of light that enter your eyes. When you look at a luminous object such as a campfire, you see the colors emitted by the fire and glowing logs. What happens when you look at an illuminated object? That depends on whether the object is opaque, transparent, or translucent.

Opaque Objects

Suppose white light strikes a box of crayons. Each crayon absorbs all wavelengths of light except its color. For example, the green crayon absorbs all colors except green. The green wavelengths of light reflect back into your eyes, and you see green. The red crayon absorbs all colors except red, and it reflects red. The black crayon absorbs all colors. The color of an opaque object is the color of light it reflects.

What do you think would happen to the colors of the crayons if you shined red light, instead of white light, on them? Would the green crayon still appear green? No. It would absorb the red light, but there would be no green light to reflect. The green crayon would appear black. The blue crayon also would appear black. The red crayon and the white crayon would appear red because they would reflect the red light. The color you see always depends on the color of light that the object reflects.

Transparent and Translucent Objects

Absorption, transmission, and reflection also explain the color of transparent or translucent objects. For example, suppose white light, such as sunlight, shines through a piece of blue glass. The glass absorbs all wavelengths of light except blue. The blue wavelengths pass through the glass to your eyes. If the blue glass is translucent, it still transmits only blue light, but the image is blurry. The color of a transparent or a translucent object is the color it transmits.

Combining Colors

You can make many different shades of color from a few basic colors. However, if you mix too many colors, you get black! Why does that happen?

Combining Pigments In a set of watercolors, each color contains different pigments, or dyes. Each pigment absorbs some colors of light and reflects others. Mixing pigments produces many different shades as the mixture absorbs certain wavelengths and reflects fewer colors to your eyes. As you add each color of pigment, the mixture gets darker and darker because more colors are absorbed. Cyan, magenta, and yellow are the primary pigments. When you combine these pigments in equal amounts, you get black, as shown in the table below.

Combining Colors of Light Red, green, and blue are the primary light colors. If you shine equal amounts of red light, green light, and blue light at a white screen, each color reflects to your eyes. Where two of the colors overlap, both wavelengths reflect to your eyes, and you see a different color. Where the three primary colors of light overlap, all colors reflect and you see white light, also shown in the table below.

Combining Colors

Combining Pigments	Combining Light
magenta + yellow = red	green + blue = cyan
yellow + cyan = green	blue + red = magenta
cyan + magenta = blue	red + green = yellow
magenta + yellow + cyan = black	green + blue + red = white