



# Properties of Light

# All About Light

What is light?

It is a small part of the EM spectrum, but it is the one we are most familiar with.

How fast does light travel?

The speed of light! This is 300,000km/s in space, or 197,000km/s in glass.

How big are light waves?

From 400nm to 700 nm in length.

# More about Light

How big is a nm (nanometer)?

It is one *billionth* of a meter! ( $1 \times 10^{-9}$ )

What happens when light strikes an object?

- **absorbed**: transferred to the object (mainly as heat)
- **reflected**: it bounces off (such as with a mirror)
- **transmitted**: goes through (such as with glass)

# Light & Objects

Objects are classified by what they do to light:

- **opaque**: Does not allow light to pass through. All light is either absorbed or reflected.
- **translucent**: Can be seen through, but not clearly. Allows some light to go through, but some is also absorbed or reflected. (such as waxed paper)
- **transparent**: Allows almost all light to go through, so can be seen through clearly. (such as window glass)

# White Light

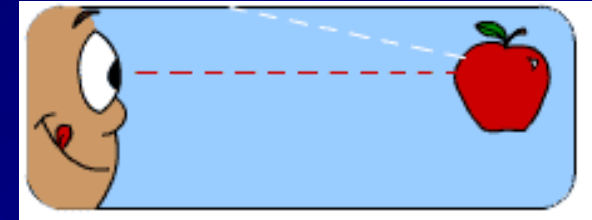
White light is made up of **all** the colors of the rainbow. *How do we know?*

Because a prism splits the light into its component colors.



So... how or why do we see colors?

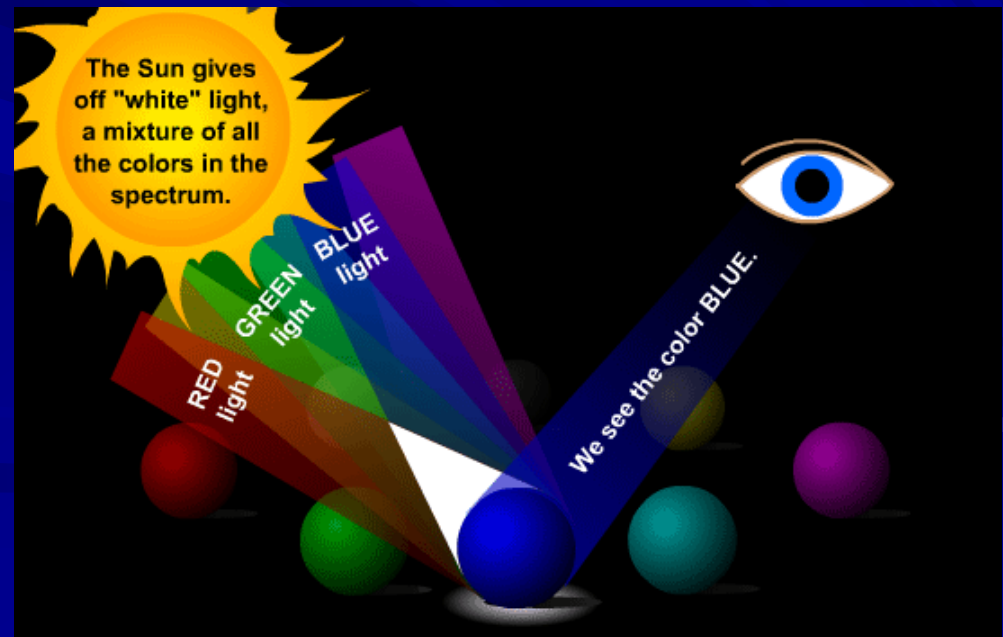
We see the color of light being **REFLECTED** from an object.



For example, a blue object reflects blue light and absorbs all others.

A black object absorbs all colors of light and doesn't reflect any.

A white object reflects all light and absorbs none.

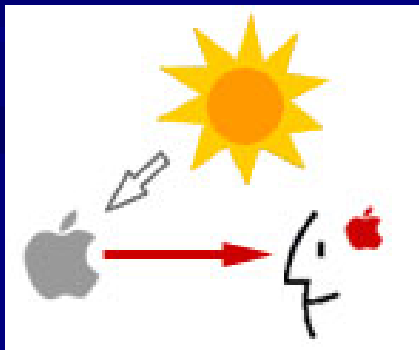


# Subtractive Color System

So, what makes a red car appear red and a blue car appear blue?



Objects create color by subtracting or absorbing certain wavelengths of color while reflecting other wavelengths back to the viewer. This **subtractive color system** uses colorants and reflected light. You start with an object that reflects light and use colorants (dyes or pigments) to subtract portions of the white light that is shining on the object. The colors are **cyan, magenta and yellow**.



So—the red car really has no color; it reflects the wavelengths of white light that cause us to see red and absorbs most of the other wavelengths.

# Additive Color System

How do monitors and TVs display color?

They produce color based on the **additive color system**, which involves light emitted directly from a source before an object reflects light.

A TV screen or computer monitor creates color using the primary colors of light: **red, blue and green**. From these three colors a wide range of colors can be produced.

Thousands of red, green and blue phosphor dots emit light to make the images seen on monitors.

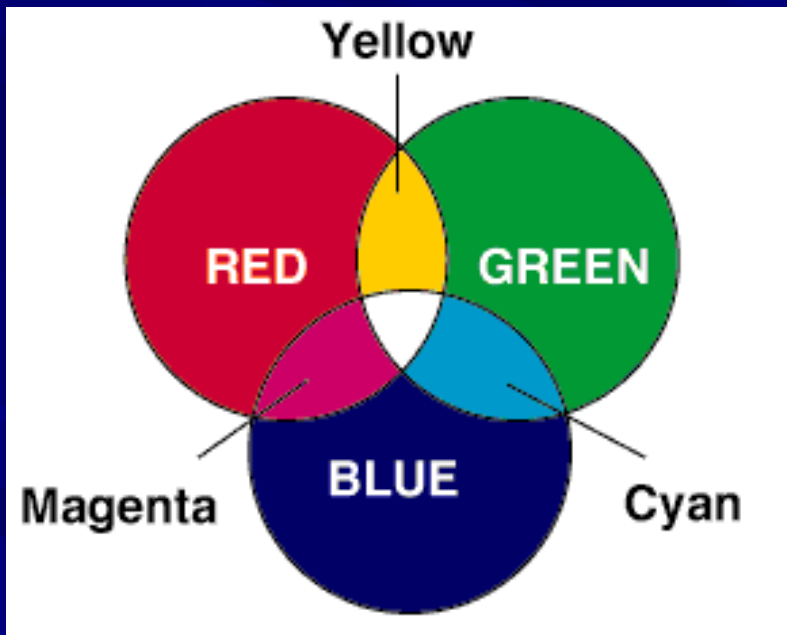




The three **primary colors of light** are:

**red, green and blue**

(Remember this is LIGHT!)



All colors we see are made from these three colors being reflected in different combinations and amounts.

Three **secondary colors of light** are made by combining two primary colors in equal amounts:

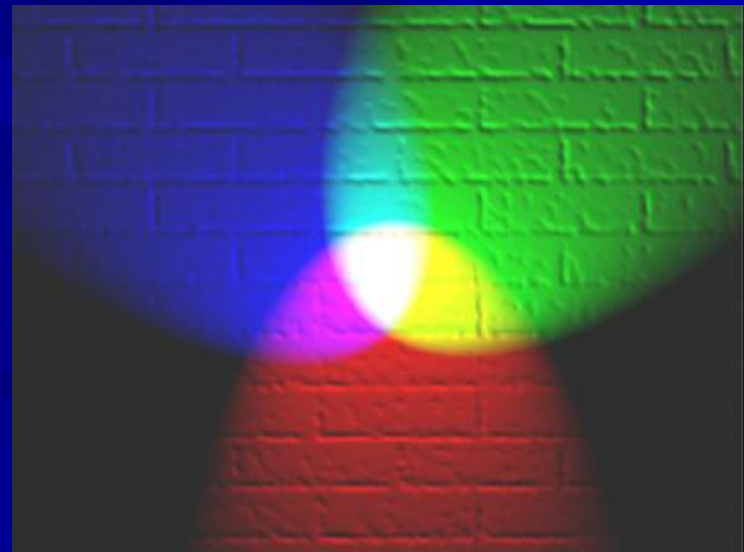
red + blue = **magenta**

blue + green = **cyan**

red + green = **yellow**

Since white light is all colors of light, mixing red + green + blue light = WHITE light

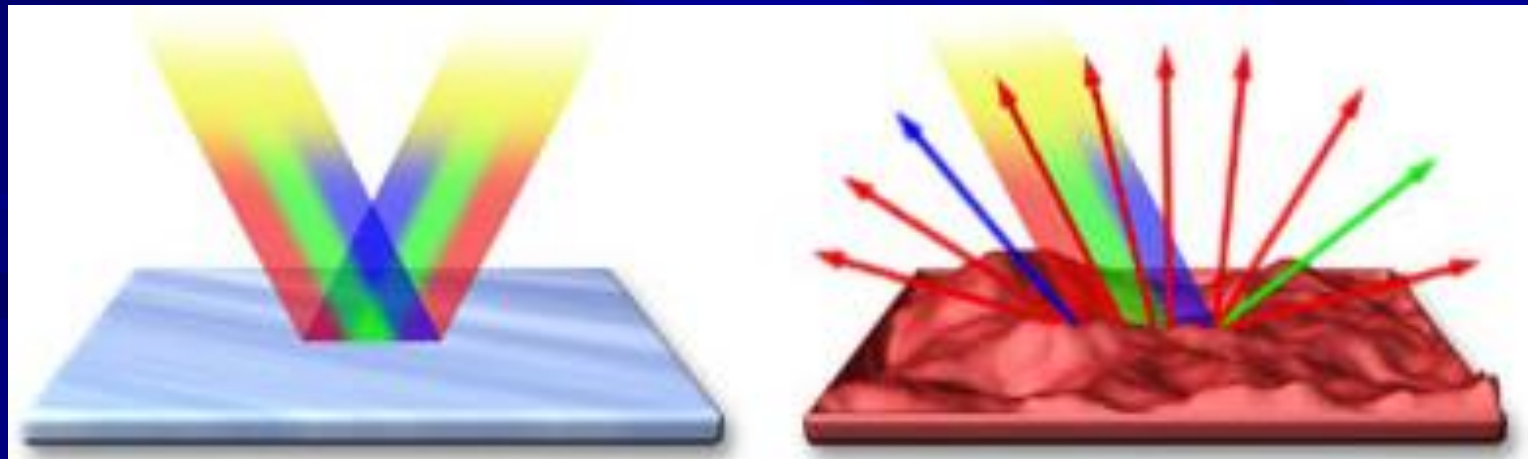
(Mixing the primary pigment colors: yellow, cyan and magenta = black)



# Light and Reflection

Two types of reflection are:

- **regular**: When an object surface is smooth, and you see an image. Example: a plane (flat) mirror
- **diffuse**: When a rough surface scatters light in many directions, and no image appears. Example: paper is rough enough to scatter light so there is no image



# Light and Refraction

Light slows down as it goes from space to air. It slows down even more in water and glass. *Why?*

The atoms get in the way.

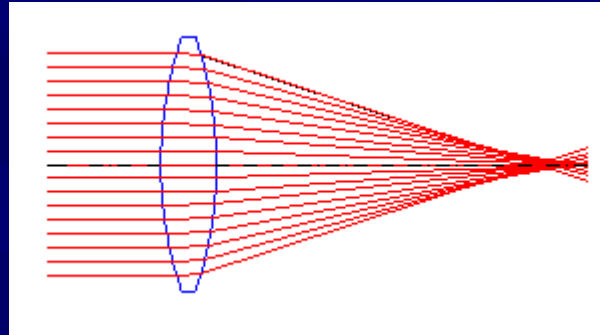


We use lenses to curve light on purpose.

(A lens is a clear, curved transparent object used to bend light.)

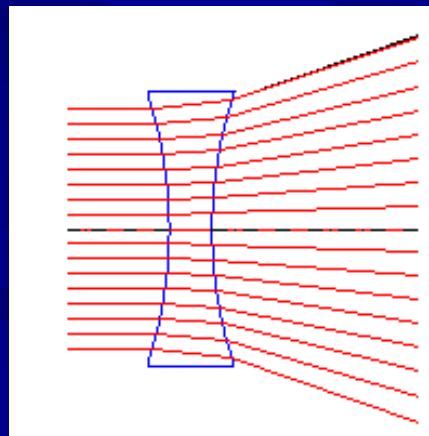
**Convex** (or positive) lenses **converge** (or focus) light and can form **images**.

light source →



**Concave** (or negative) lenses **diverge** (or spread out) light rays.

light source →

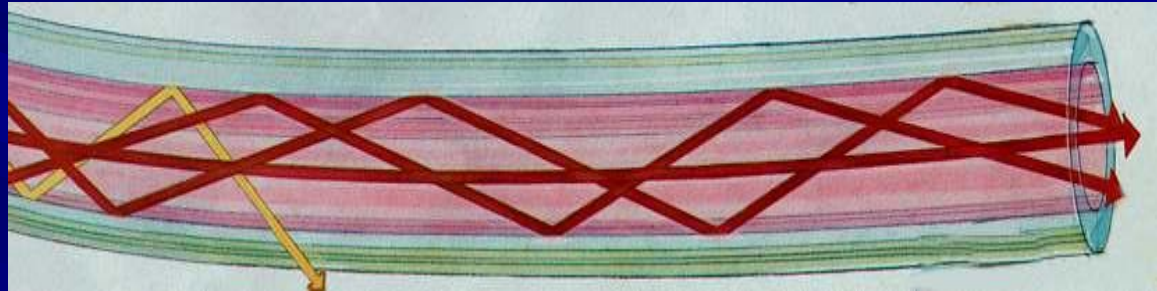


# Total Internal Reflection

If light strikes a boundary between two transparent materials at the correct angle, all the light gets reflected.

outside material →

inside material →



This is how fiber optics works, in a process called  
“**total internal reflection.**”

# Lasers



Laser = **light amplification by stimulated emission of radiation**

Lasers use one wavelength of light, so that all the crests and troughs are lined up (or “in step”).

This way, they do not interfere with each other and spread out, like white light in a flashlight.

Lasers are used for welding, cutting materials (metals, biological tissue), reading/writing CDs, transmitting data through space or optical fibers, or simply as pointers.

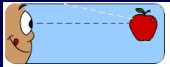
# Image Sources



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Redmond, WA 98052-6399 USA.



Lawrence Berkeley National Laboratory [http://pdgusers.lbl.gov/~aerzber/refr\\_applic.html](http://pdgusers.lbl.gov/~aerzber/refr_applic.html)



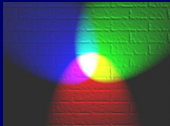
The NSAS SciFiles <http://scifiles.larc.nasa.gov/text/kids/Problem Board/problems/light/sim2.html>



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NASA <http://science.hq.nasa.gov/kids/imagers/teachersite/UL1diag.htm>



en>User:Bb3cxv , Wikipedia [http://en.wikipedia.org/wiki/File:RGB\\_illumination.jpg](http://en.wikipedia.org/wiki/File:RGB_illumination.jpg)



Microscopy Resource Center, Olympus  
<http://www.olympusmicro.com/primer/java/reflection/specular/index.html>



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