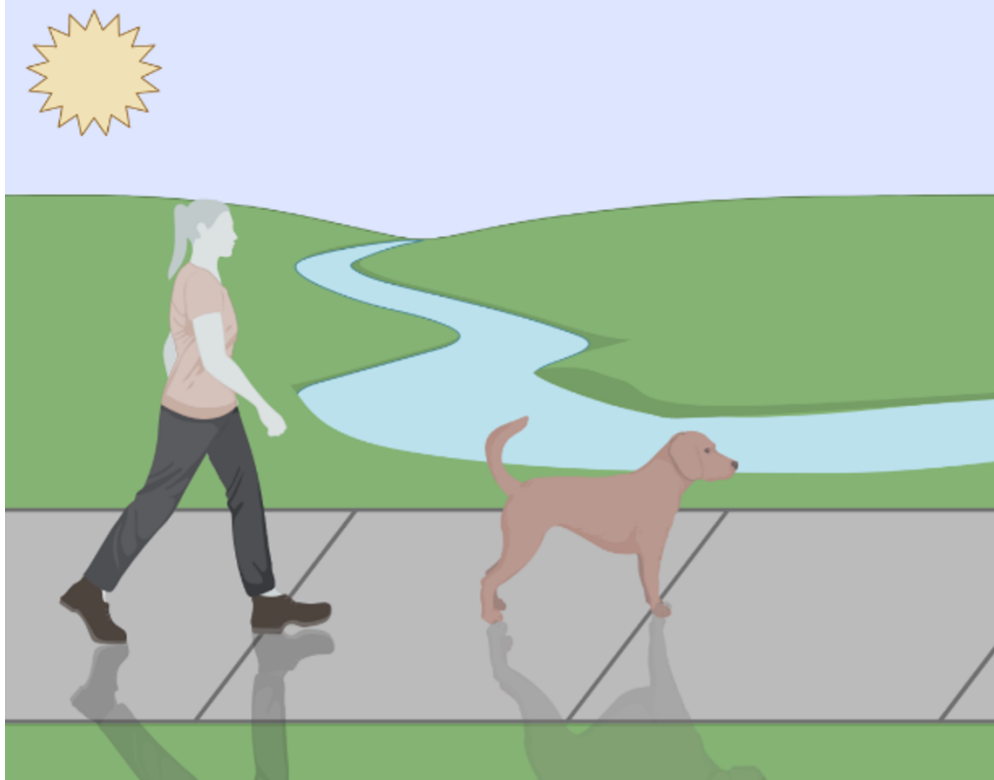


What is a shadow & how do we make one?

Shadows are a part of our everyday lives, so much so that we seldom give their existence a second thought. When they are brought to our attention, they're most often in the form of playful dark outlines of ourselves who dance across the ground on a sunny day. Other types of shadows, however, can be harnessed in many other ways. They can be used with puppets to pass on stories. They can be used with special paper to create photographs. They can even be used to magnify creatures that are too small to be seen with the naked eye. If you're wondering how the latter is possible, keep scrolling as we dive headfirst into the world of shadow making.



To help us understand how a shadow is formed, let's first take a look at the definition of the word:

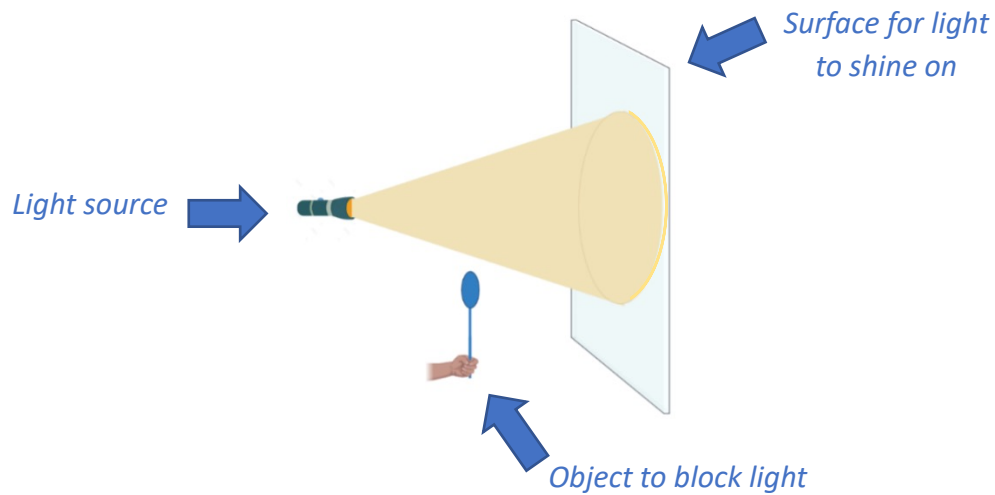
Shadow (n):

A dark area or shape produced by an object coming between rays of light and a surface

Seems pretty straightforward, right? The shadow you see when you walk outside is just a dark, person-shaped area formed because your body is blocking light from the sun from being able to reach the ground. To help us think about this concept, let's use a model:

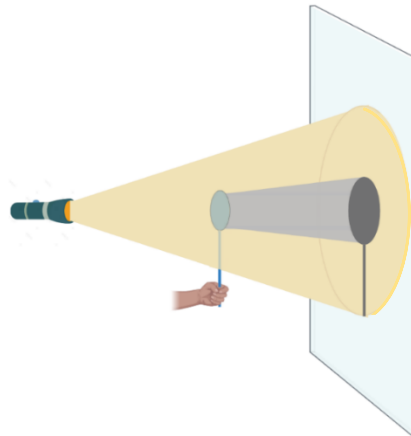
Below we have all the supplies to make a shadow:

1. *A light source*
2. *An object to block the light source*
3. *A surface for the light to hit*



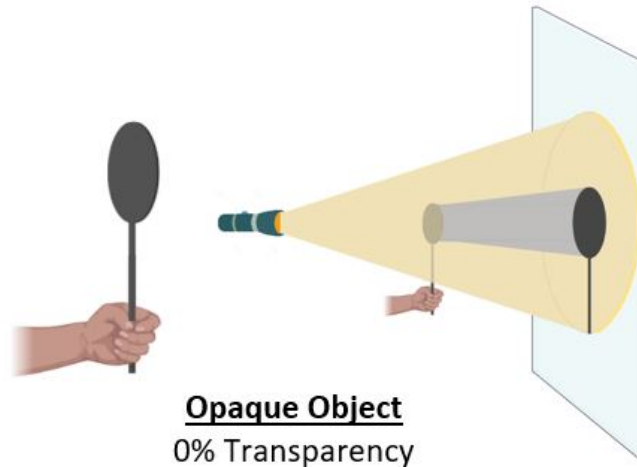
Now, let's make a shadow:

You will notice now that the object has moved into the light, the light illuminates the object and is blocked from reaching the white surface behind it.



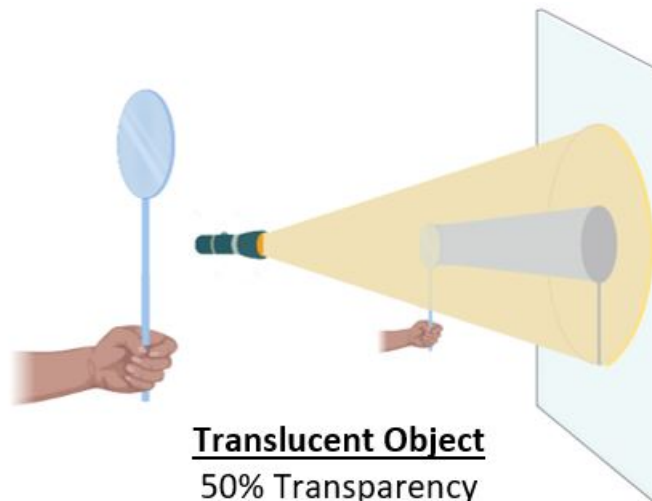
Did you know there are different types of shadows?

That's right! The shadow produced depends on the material that the light-blocking object is made from. We call the light blocking ability of the object its transparency. Objects can range from completely transparent, not at all transparent, and everything in-between. Let's take a look at three different kinds of objects and the shadows they form:



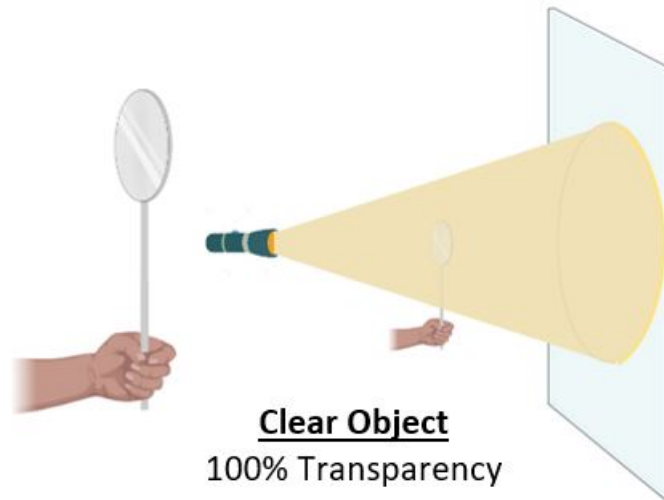
This is what it looks like when an opaque object, an object that light can't pass through, creates a shadow.

Observe how dark and clear the shadow appears on the white background.



A translucent object can allow some light to pass through, but not all of it.

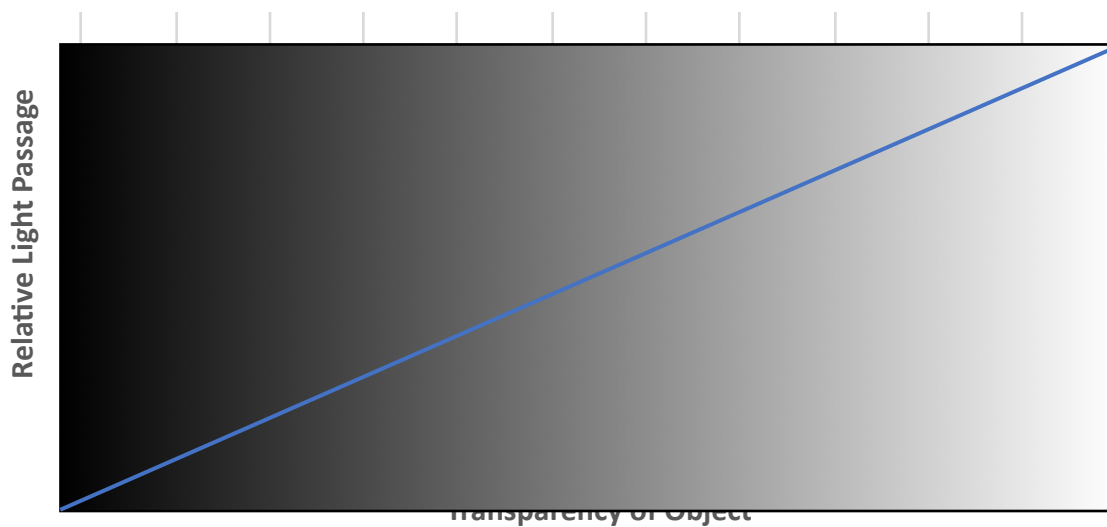
This type of shadow is lighter in color, but still allows the outline of the object to be seen.



Clear objects allow all light to pass through them.

As you can see, these objects do not create an observable shadow.

Higher Transparency Means More Light Passage

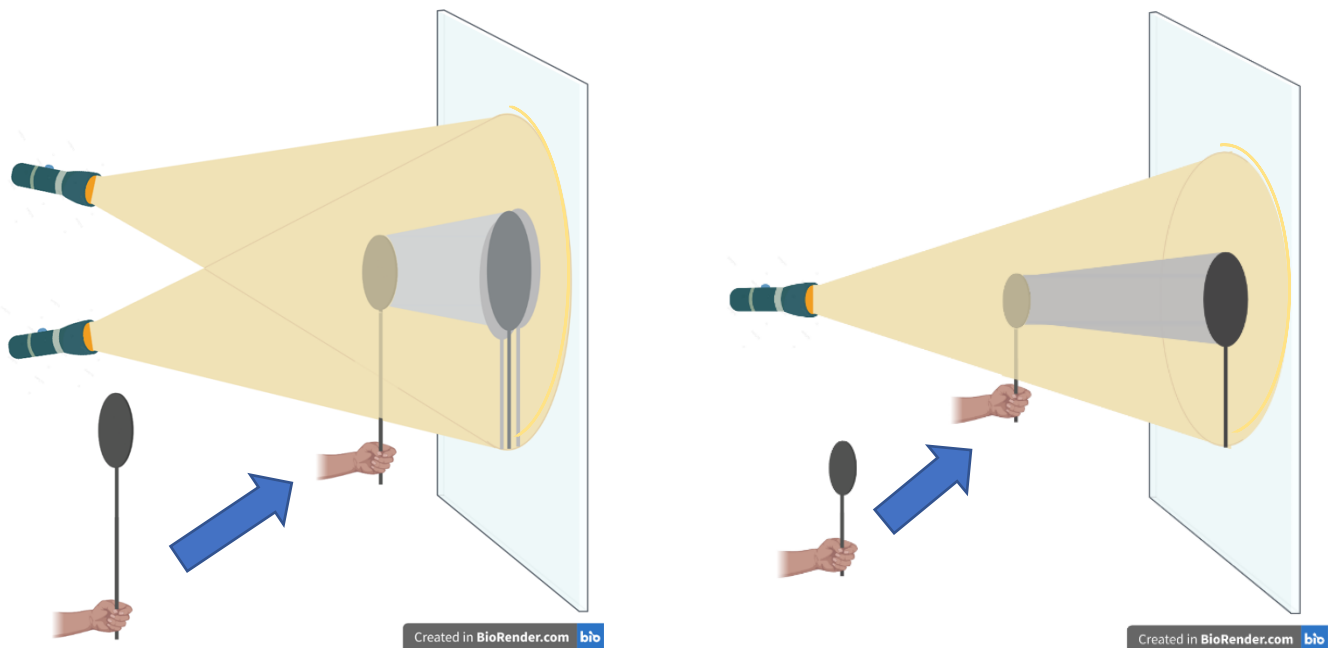


How do we make the best shadow?

Now that we've looked how different objects create shadows, let's look at what types of light sources produce the "best" shadow.

A good shadow will have a crisp, clear outline of the object we are using to make the shadow.

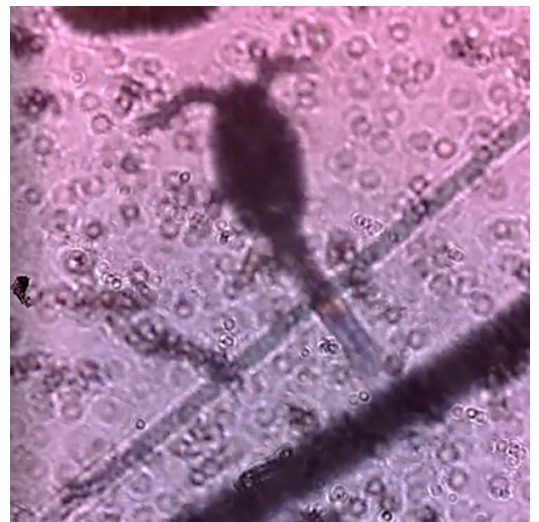
Single Light Source vs. Multiple Light Sources



How does this apply to the shadow scope?



The Shadow Scope uses a single light source to create a visible shadow of organisms that are on a microscope slide! This allows us to easily visualize microscopic critters live in water. Below, you will see images of a freshwater copepod. image on the left was obtained using a regular light microscope while the image on the right was obtained using a Shadow Scope!

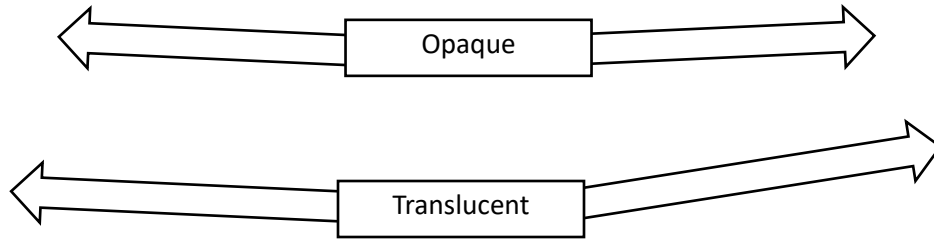


can see that parts of the copepod are translucent while other parts are opaque.

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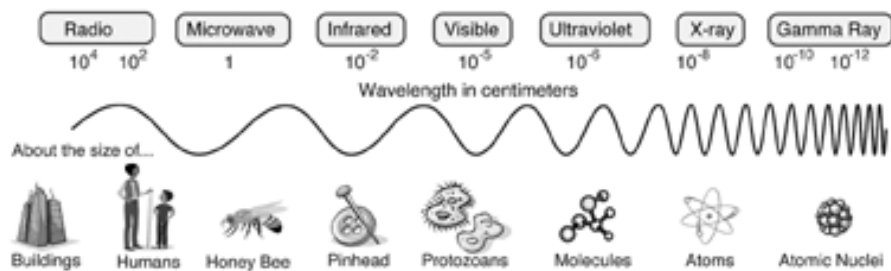
You



What is light and how do different types of light affect shadows?

By now, we know that light is a required component of creating a shadow, but you might be wondering, what is light?

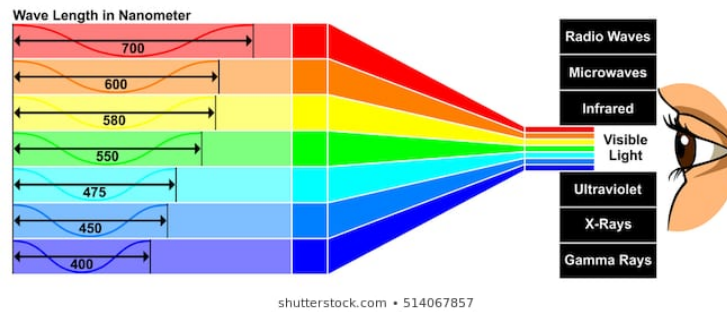
Light is considered a type of **electromagnetic radiation**. **Electromagnetic radiation is a type of energy that moves in the form of a wave.** We differentiate radiations based upon the amount of energy that the radiation possesses. There are many different types of radiation that we interact with every day, and we utilize each type almost every single day!



<https://imagine.gsfc.nasa.gov/educators/gammaraybursts/imagine/page7.html>

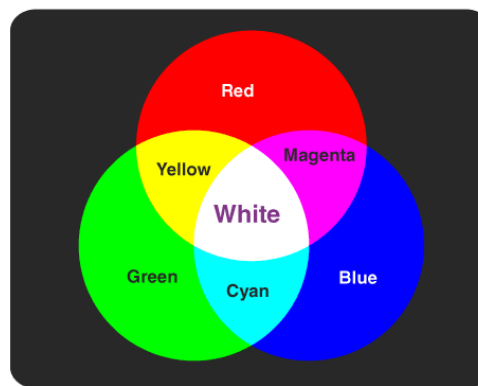
For example, radio waves are low-energy waves that we use to communicate with one another over long distances. Microwave radiation is used to heat up our food. Infrared radiation is most notably identified when we can feel warmth from an object, such as the stove or our own skin. Then, we reach visible radiation which makes up the light we can see. Next, we have Ultraviolet radiation which is high-energy and can burn our skin if we are exposed to it for too long.

Visible light is broken down into different colors based upon the energy of the waves. Low-energy waves produce red colors while high energy waves produce blue-violet colors.



<https://azretina.sites.arizona.edu/node/481>

White light is a combination of all the wavelengths of light put together. When different colors of light overlap, they create different resulting color combinations. For example, when red and green light overlap, they create yellow light.



BYJU'S
The Learning App

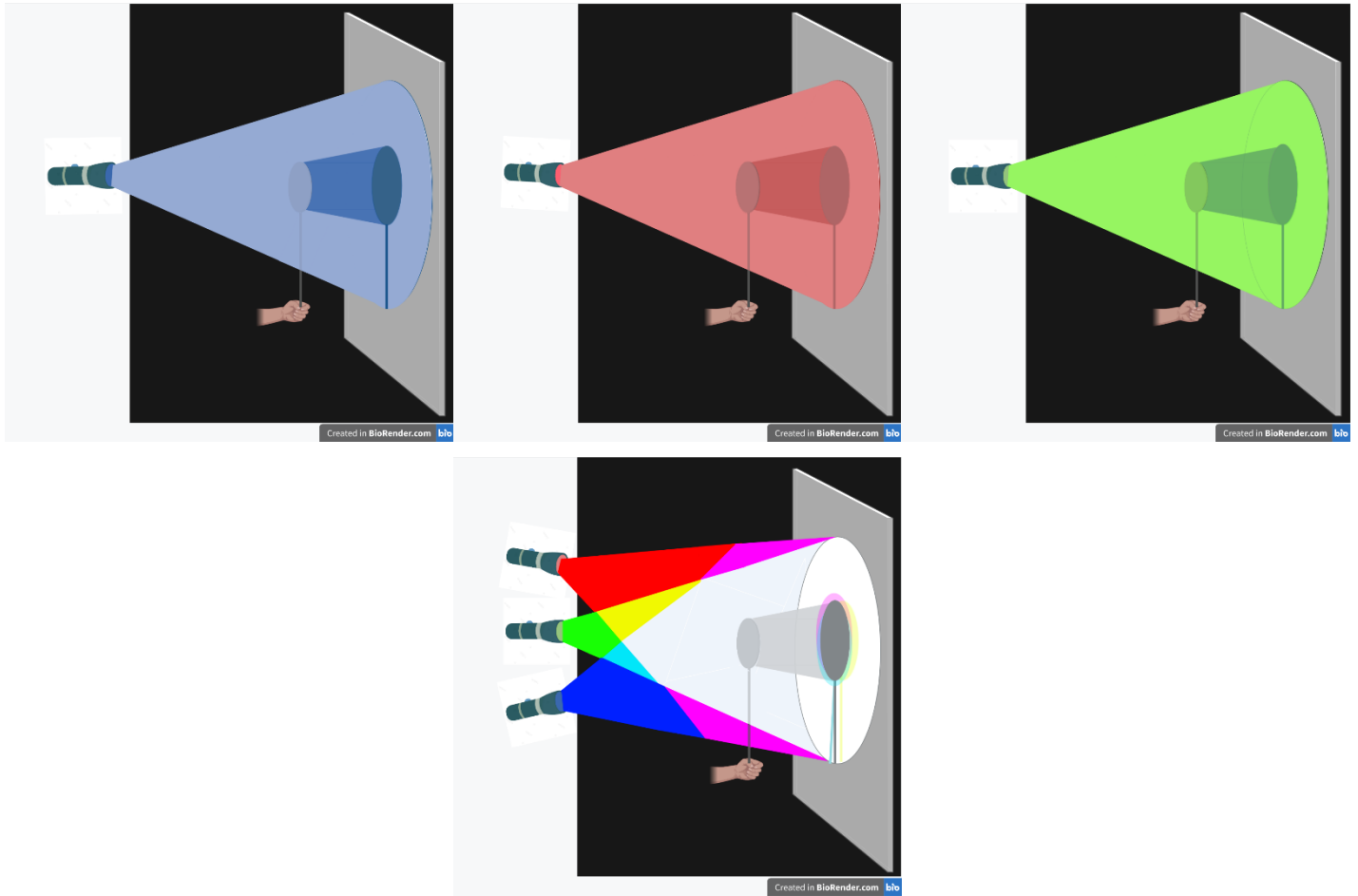
<https://byjus.com/physics/white-light/>

Up to this point, we have been examining shadows that are created by white light! But, what happens when we use different colors of light?

Different Colored Light Sources

Now that we know white light is a combination of the different colors of light, we can start to look at what would happen when we use different colored light sources to create a shadow!

What happens when we use one color of light? What about multiple colors of light?



As you can see, multiple colors of light combine together to produce white light; however, you can still see evidence of each colored light sources in the shadow created by the object we block the light with!

Citations & Additional Resources

<https://imagine.gsfc.nasa.gov/educators/gammaraybursts/imagine/page7.html>

<https://byjus.com/physics/white-light/>

<https://www.kennedy-center.org/education/resources-for-educators/classroom-resources/lessons-and-activities/lessons/6-8/the-science-of-shadow-puppets/>

<https://www.exploratorium.edu/snacks/colored-shadows>