From the Light & Color Gallery: Rays!

Have you seen your reflection today? In our Light & Color Gallery, you can dive into the world of reflection at our Rays exhibit. Let's build our own Rays exhibit and make some discoveries about light and reflection from the comfort of our home laboratory. Please share your experiences with us using the email address found on the last page. We'd love to know what you discover!

Starter Exploration

Is a mirror the only place you can see your reflection? Let's take a moment to investigate!

Grab pencil and paper—or whatever works for you—to record your findings. Walk around your home, including outside if you can, and try to find as many reflections as you can. Look carefully into surfaces and objects all around you.

Which materials provide the clearest reflection? The blurriest?

Which reflective surfaces surprise you?

Does changing the lighting in an area change the reflection?

Using words and pictures, record what you discover during your travels searching for your reflection. Once you're warmed up from your reflections scavenger hunt, let's start on our Rays exhibit!

Make Your Own Rays Exhibit

Supplies

Be sure to ask an adult for help as you gather your supplies to create your exhibit!

- Light source: an old-fashioned flashlight or headlamp will work best. Cell phone flashlights and colored lights will work, too, but may produce slightly different results.
- Objects to hold close against your light source, including:
  - White or light paper
  - Black or dark paper
  - Cardboard
  - Clear plastic, like a recyclable food container
  - Colored plastic, or, **with permission from your adult**, color a clear plastic recyclable with marker. *Please note that some marker ink might*

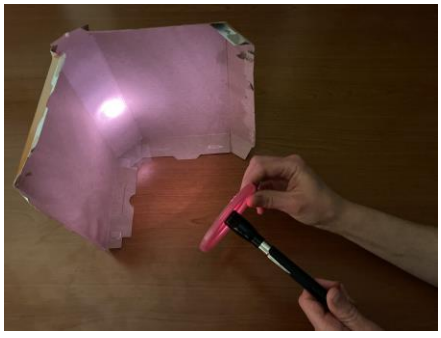
wipe off easily, so be careful coloring and using your newly tinted plastic.
    - Tracing, tissue, parchment, or waxed paper
    - Tin foil or metal can
    - Anything else you want to test! (See photo.)
- Small handheld mirror
- Cardboard or paper to make a projection screen
- Small cardboard box for enclosing your light source, like a granola bar box or tissue box—something you can cut into
- Something to prop up your projection screen if needed (see photo below for example projection screens)
- Marker or pen
- Scissors
- A darkened space to view your experiments

*Don't have the suggested supplies? Not sure if what you have will work? We've got you covered! Check out the "**Get creative!**" section below for tips on how to build and troubleshoot your Rays exhibit.*

Exploration: Light and Everyday Objects

- Make a projection screen—a fancy term for a surface you shine light onto—out of cardboard or solid color paper (see photo). Or you can use a wall as your projection screen.
- Collect your projection screen, light source, and objects to hold in front of the light, and head to a space with low light.
- In your low-light lab, set up your projection screen, and turn on and position your light so that it shines onto the screen.
- Observe the light on the screen as you hold different objects between your light source and your screen (see photo).

What do you notice?



Things to try

- Guess, or hypothesize, what will happen to the light beam as it passes through different materials.

  What do you notice about the materials that let light through and the materials that don't?

  Do any of your materials do a little of both?

- If you have any colored materials you have made or collected, compare what the light looks like on your projection screen before and after placing them in the light's path.

  What do you notice?

- Hold your dark and light paper in front of your projection screen and alternate placing them across your light beam. Look at the light shining on the papers as you do this.

  What do you observe about the brightness of the light?

- Now try putting some space between your light source and your objects (see photo).

  What do you notice about the light when it hits these metallic surfaces?

  Does the light behave the same way with each object?

What's going on?

When you point your light source at your projection screen, what do you see? When you put objects in front of your light source, does it change what you see on your projection screen?

Light energy has puzzled and captivated us for thousands of years. It makes us feel warm on a sunny day, helps our food to grow, and when it enters our eyes, light energy makes it possible for us to see the world around us. When you shine your light onto your projection screen, you are watching light energy travel from a light source to an object—your projection screen—and then bounce off the object and into your eyes!

What happens when you place an object in the pathway of the light energy? Objects that are *opaque* fully block the light's path, resulting in a dark projection screen. Objects that are *translucent* allow some light to pass through them. On your projection screen, this may look like a dimmed, blurry, or diffuse

spot of light. And if any of your objects don't really alter the appearance of the light on your projection screen, these objects are most likely *transparent,* meaning they allow the light to pass right through them.

What about objects that change the color of your light? The prolific Sir Isaac Newton (the Newton of Newton's laws *and* gravity!) taught us way back in the 1600s that white light actually contains colors. You see these colors when you look at a rainbow, whether it's a rainbow in the sky or one dancing on the wall from light passing through something in the room. In your Rays exhibit, when light passes through your colored translucent object—also known as a *color filter*—only the light that is the same color as your object shines all the way through your filter and out the other side, appearing as colored light on your projection screen. Because white light is made up of colors, we can use different tricks like color filters to single out certain colors of light.

We can also use color to change the brightness of light. When you shined your light onto your dark and light pieces of paper, you watched light bounce—or *reflect*—off the colored paper. You may have noticed that the spot of light on the dark piece of paper looked dimmer than the spot of light on the lighter colored paper. This difference in brightness occurs because dark colors hold onto, or *absorb*, more light than lighter colors, which reflect most of the light back into the world and our eyes. This explains why rooms with white walls seem so bright—light bounces off of the white walls and speeds around the room. And in theaters and performance halls where lighting is critical to the audience's experience, stages are often black, enabling stage managers to closely control the lighting on the performers.

When you moved your objects farther away from your light source, what did you notice?

Did you see light energy bouncing around and reflecting back at you?

To play some more with light reflections, let's return to our laboratory!

Exploration: Light and Mirrors

Make an enclosure for your light source using a cardboard box. This enclosure will allow your light source to project light from one end of the box all the way out the other side through a wide slit. Let's make our enclosure step by step:

- Look at your box and decide at which end of the box your light source will sit. If possible, orient you light source so that it will shine onto a side of the box that is taller than your handheld mirror.

- Now mark where you will cut your box. Looking at the end of the box opposite where your light source will sit, draw a line that starts at the edge and is at least as tall as your handheld mirror (see photo).

- With help from your adult, cut along your line to make a slit in the box. Widen the slit just a bit so that the light can clearly pass through it. We will now call the side of your box with the slit the "front" of your enclosure (see photo).
- If you are using a cell phone flashlight as your light source, have your adult:
    - Cut a small piece of paper or thin cardboard to cover the flashlight.
    - Poke a small hole in the cardboard to allow a tiny portion of the light to pass through.
    - Tape this piece of cardboard over the flashlight on the phone (see photo).

- Collect your enclosure box, light source, and mirror. Head to a lab space that is dimly lit and has a flat surface like a table or a floor that you can lie on.
- Place your enclosure on your surface and set your light source at the back of your box.
- Turn on your light source and check that light streams out of the cut in the box (see photo). Make any adjustments necessary.

- Grab your handheld mirror and place it in the path of the light beam (see photo). You may need to adjust your setup to get the mirror and light to intersect. (For example, I had to hold my light up a little bit in my enclosure.)

When you hold your mirror in the light's path, what do you notice?

*If your Rays exhibit doesn't give you the results you want, be sure to check out the "**Get Creative!**" section below for tips on how to build and troubleshoot your homemade exhibit.*

Things to try

- Tilt your mirror up down. Look at front of your enclosure.
  What do you observe?
- Turn your mirror side to side. Look at the front of your enclosure.
  What do you observe?
- Tilt your mirror towards the ground and then turn your mirror side to side. Look at the table or floor that your Rays exhibit is on.
  What do you observe?
- Once you can see the reflection of your light—the reflected ray—on your lab bench or floor, try directing the reflected ray to certain places around your lab.
  What do you notice?
- Move your flashlight forward and backward in your enclosure.
  What happens to your light beam? And the reflected ray?
- Try using other materials to reflect the light, like tin foil, a metal can, or other metal objects.
  What do you notice about the light when it hits these different materials?

Get creative!

Remember, experimenting is about trying new things, observing what happens, and then trying more new things. Not all of the supplies and setups you try will work equally well, and that's ok! It's an experiment! Here are some questions to help you get creative and practice your troubleshooting…

- Don't have a small handheld mirror? No problem! You can reflect light off of any mirror in your home. Hold your projection screen up (from **Exploring Light**), and you can catch the reflected ray coming off of the mirror. Move your light source around to move your reflected ray, or, if the mirror hangs on a door or cabinet, you can swing the door a little bit and watch what happens!
- Is your light not emitting from your box? Make sure your slit is wide enough and that your light source shines through the slit. Clear away any

cardboard that is blocking the path of your light. You can also use tape to secure your light source if it's wiggling around too much.

- Is your light emitting from the box, but it's hard to get a clean reflected ray? You may need to widen the opening in the box. You can also try moving the light source around in the box. If all else fails, grab a new box, or flip your box around, and create a new setup for yourself.
- Can't see your reflected ray on your lab bench or floor? Consider the following:
    - Does your mirror have a large frame around it? Adjust your exhibit so that the light clearly shines on the mirror and not its frame. If you are working on a table, you can also hold the mirror at the edge of the table to avoid the large frame (see photo).
    - Is your mirror too far from your enclosure?
    - Are your light source and mirror aligned? You may need to tilt, turn, shift, or prop up one or several parts of your exhibit to secure them where you want them.

What's going on?

When you point your mirror down towards your lab bench or floor, what do you notice? What happens when you move your mirror around?

Mirrors are made of smooth glass and shiny metal, and these materials and their properties enable us to see clear, sharp images when we look into them. These properties are also what allow us to use a mirror to control where our reflected ray travels in our laboratory. Are you able to move your reflected ray where you want it to go? If so, you are using something called *The Law of Reflection*. Perhaps without knowing this law, you have demonstrated it again and again with your Rays exhibit!

Most of us depend on this *Law of Reflection* each and every day. It allows us to effectively use mirrors to comb our hair and for drivers everywhere to safely back up in cars, buses, and trucks by looking into carefully placed mirrors so they can see what is behind them. Dentists use mirrors to check our teeth, microscopes use mirrors to help us see the world of the very tiny, and telescopes use mirrors to help us see the world of the very far away. The Law of Reflection tells us exactly how light will reflect off of a mirror (light bounces off of a mirror at the same angle it arrives at the mirror), and this allows us to use mirrors to see things we otherwise couldn't see.

As you may know—or have discovered here—mirrors are not the only objects that reflect light. An object doesn't have to be flat or smooth to reflect light, and it doesn't have to be metal or glass, either. Light is energy that reflects and passes through objects all around us, each and every day. Mirrors and their shiny metal and glass play a special role in our world of light and reflection, but light bounces off of objects all around us, illuminating our world.

Discovery Museum Rays Challenge

Let's return to our reflections scavenger hunt from our **Starter Exploration** at the beginning of this document. This time we're in search of reflections with a little something extra going on—stretching, shrinking, multiplying, upside-downing, and any other distortions you can discover.

- Grab your record keeping tools again.
- Walk around your home, including outside if you can, and try to find as many funky reflections as you can.
- Look for curved surfaces, flexible surfaces, and places where reflective materials intersect.

Which reflective surfaces surprise you?

When exploring a curved surface, does the type of curve affect what you see?

Do any of your surfaces shift when touched or blown? What happens to the reflection?

Can you find a way to see multiple reflective images by using one object? Two objects? More than two objects?

How many reflected images can you make?

Using words and pictures again, record what you discover during your travels searching for your distorted and multiplied reflection. How do these notes compare to the first ones you took? Perhaps they reflect a little bit of what you've learned!

Share your discoveries with us!

We want to know about your Rays exhibit and adventures in reflection. Share your experience with us in any of the following ways:

- Draw a picture
- Take photos of your Rays setup
- Take photos of reflections you observed around your home
- Write down which supplies were your favorites to use, why you liked making your own Rays exhibit, or any other fun things you discovered

Then email us at myhomediscoveries@discoveryacton.org, we can't wait to hear from you!

And next time you're at the Discovery Museum, check out our Rays exhibit in the Light & Color gallery on the first floor, and show us what you learned from the exhibit you created at home. And remember to look for your reflection around the Museum. We'll see you here!

Want even more Rays fun?

Check out these resources!

More Mirror Fun
https://lifestyle.howstuffworks.com/crafts/seasonal/science-experiments-for-kids7.htm

Make a Periscope
https://redtri.com/diy-periscope/