

SCIENCE AT HOME

LIGHT AND OPTICS

GRADE: **10**

SNC2D, SNC2P

SUBJECT: SCIENCE

STRAND: PHYSICS

TOPIC: LIGHT AND OPTICS

EXPECTATIONS: SNC2D: E1.1, E1.2, E2.1, E2.2, E2.4
SNC2P: E2.1, E2.2, E2.3, E2.4, E2.5, E2.7

VIDEO: youtu.be/HgMLcpmwrc4

INTRODUCTION:

Everyone takes pictures, but do we really understand how cameras work? Do we understand how our own eyes work? Build your own pinhole projector and discover through experiments how images are formed, how light travels and what's special about convex lenses.

ACTIVITY: Make a pinhole projector

TIME: 30 minutes

SAFETY:

To see the image from the pinhole projector, you need to be in a completely dark room. Before turning off the light, make sure you know how to turn it back on! And be careful not to stumble over anything in the dark.

You will use scissors to cut cardboard – take your time.

WHAT YOU NEED:

- Cardboard box that can be fully closed
- Scissors
- Aluminum foil
- Tape
- Black tape (optional)
- Flashlight
- Small sharp object (skewer, toothpick, nail)
- Phone or tablet with a bright screen
- Completely dark room
- One or two magnifying glasses (optional)



WHAT YOU DO:

Build it:

- Cut a hole the size of your fist into one side of the cardboard box, using scissors.
- Tape aluminum foil over the hole, so that it's fully covered.
- Check the box for gaps where light could get through. To identify light leaks, place a flashlight inside. Patch any gaps with black tape or aluminum foil.

Set it up:

- Use a room that is completely dark when the lights are turned off – this will be much easier to do at night. Make sure that absolutely no light gets into the room, because even small amounts of light will ruin the effect.



**ONTARIO
SCIENCE
CENTRE**

An agency of the
Government of Ontario

WHAT YOU DO (continued):

- Turn on the phone or tablet and play a cool video, or change your settings so that the screen won't turn off.
- Tape the phone to the inside of the cardboard box opposite the aluminum foil, so that the screen is facing the aluminum foil. Leave the screen turned on.
- Close the lid or the flaps of the cardboard box.
- Place the box about half a metre away from a light-coloured wall, with the aluminum facing the wall.
- Turn off all the lights in the room. Wait at least 30 seconds for your eyes to adapt to the darkness. Be patient: the longer you wait, the more impressive this is going to be.
- Use the small sharp object to make a single hole in the aluminum foil.
- Look at the wall.
- What do you see? What do you notice about the image?

Don't stop now:

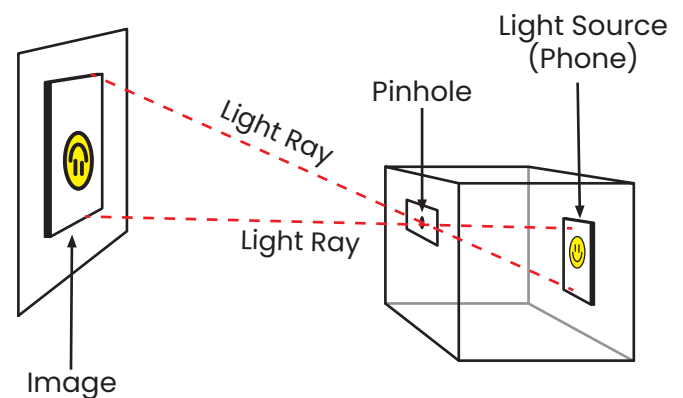
- Place your hands where the image is on the wall. Now move one hand towards the hole. What happens to the image?
- Make another hole in the aluminum foil. What do you see?
- Make more holes.
- Cover some of the holes with your hands.
- If you have a magnifying glass, place it close to the holes into the beams of light.

You might have to move the cardboard box farther away from the wall, and you will need to move the magnifying glass back and forth a bit – keep on trying – but eventually the magnifying glass will create a single image of your screen.

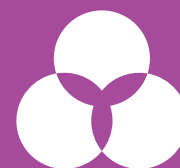
- Make a big hole – can you still capture the image with a magnifying glass?

WHY THIS MATTERS:

The image you see on your wall is produced from the few rays of light that manage to make it out through the pinhole. Each light ray travels from a specific spot on the light source (in this case, your phone screen) in a straight line through the hole, and it makes a spot on the wall.



Every time you poke a new pinhole, another set of rays escapes the box to make another image. When you make a big hole, think of it as the sum of an infinite number of pinholes.



WHY THIS MATTERS (continued):

By using a magnifying glass, however, you can combine all those separate images into a single brighter image. The magnifying glass takes all the different light rays coming from every spot on the light source inside the box and combines them into one image.

In fact, you don't need the box to make an image if you have a magnifying glass. A magnifying glass is essentially an image-making machine: its convex lens changes the direction of the light rays – makes them converge – into one image. That's how cameras work too – not to mention the convex lenses you have built right into your head.

TAKING IT FURTHER: Investigating colour screens

How do colour screens produce such a wide range of colours?

WHAT YOU NEED:

- Glass of water
- Colour screen

WHAT YOU DO:

Look closely at any device with a colour screen. Can you see the little dots? Dip a finger into your water and flick some onto the screen. A water droplet can act like a magnifying lens, making it easier to see the colours.

What colours can you see? All colour screens have dots with the same three colours: red, green and blue. All the colours that we "see" on a screen are actually made up of just these three.

Look at different areas of your screen and use the water droplet trick to figure out which of the three colours is the brightest. Here are a few colours that might surprise you: yellow, brown, pink.

HINT:

It is easiest to do this using a TV, because the dots on a big screen are bigger.

UNPACKING WHAT HAPPENED:

Human eyes have colour receptors, called cone cells. Surprisingly, there are only three types of receptors and they detect only one colour each: red, green or blue. The cone cells send signals to our brain depending on how much light of their colour they receive, and our brains use this information to produce the perception of colour.

When you look at a yellow sunflower, for example, the green and red cone cells send strong signals to your brain. Your brain receives the signals for green and red, and it produces the perception of "yellow."

Colour screens use this same characteristic. All the colours we can see come from just three colours. Which is why we call red, green and blue the "primary colours of light."



SCIENCE AT HOME

LIGHT AND OPTICS

GRADE: **10**

SNC2D, SNC2P

SUBJECT: SCIENCE

STRAND: PHYSICS

TOPIC: LIGHT AND OPTICS

EXPECTATIONS: SNC2D: E1.1, E1.2, E2.1, E2.2, E2.4

SNC2P: E2.1, E2.2, E2.3, E2.4, E2.5, E2.7

VIDEO: youtu.be/HgMLcpmwr4

UNPACKING WHAT HAPPENED (continued):

Colour screens use this same characteristic. All the colours we can see come from just three colours. Which is why we call red, green and blue the “primary colours of light.”

MORE ONLINE:

Exploring light snacks

<https://www.exploratorium.edu/snacks/collection/color>



ONTARIO
**SCIENCE
CENTRE**

An agency of the
Government of Ontario