deSTEMber
SCIENCE ★ TECHNOLOGY ★ ENGINEERING ★ MATH
PRESENTED BY: girlstart

Pinhole Theater

Most people use their cellphones to take pictures these days but did you know all you need is a tiny pinhole to create a camera lens? Explore the movement of light rays as you make a cardboard box theater!

TEKS:

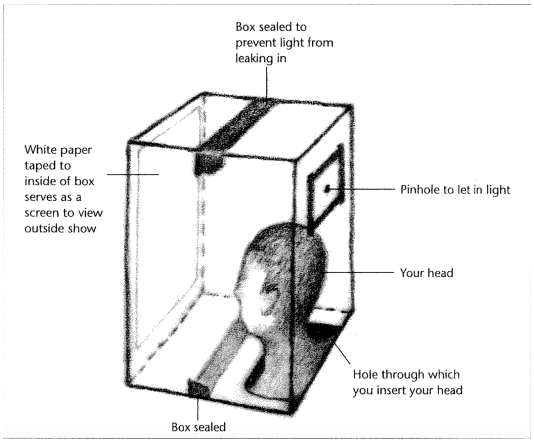
SCI 4.6 A: The student is expected to differentiate among forms of energy, including mechanical, sound, electrical, light, and thermal.
SCI 5.6 A: The student is expected to explore the uses of energy, including mechanical, light, thermal, electrical, and sound energy.
SCI 5.6 C: The student is expected to demonstrate that light travels in a straight line until it strikes an object and is reflected or travels through one medium to another and is refracted.

Materials:

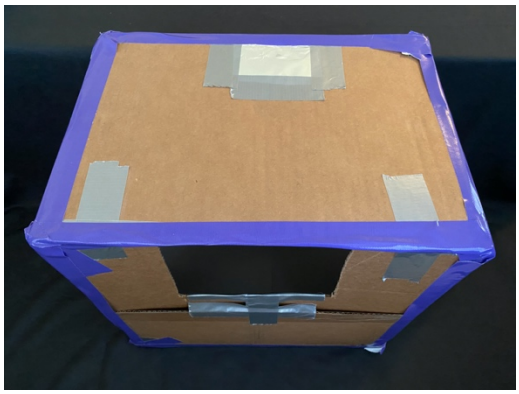
- Aluminum foil
- Black scarf, blanket, or towel
- Duct tape
- Large cardboard box (at least 20 x 15 x 15 inches)
- Pushpin
- Ruler
- Scissors
- Utility knife
- White paper

How To:

1. Before you begin, take a look at the diagram on the top of the next page so you understand the basic structure of your pinhole theater.



2. Make sure that your cardboard box has at least one side open to start.
3. Tape sheets of white paper onto the inside wall of the box that your head will be facing. This paper will act as the "screen" of your pinhole theater.
4. Close the open side of your cardboard box with duct tape.
5. Use a utility knife to cut a hole in the bottom of the cardboard box that is large enough to put your head through. See the diagram above so you know where to place this hole. **Safety: an adult should assist when using a utility knife.**
6. Use a utility knife to cut a 3 x 3-inch square in the side of the box, opposite the white paper screen and above where the top of your head would be if inside the box.
7. Cut a 4 x 4-inch piece of aluminum foil. Use tape to attach this foil to the outside of the box so that it completely covers the 3 x 3-inch opening.
8. Place the box on your head and check the corners and seams of the box for light. Remove your head and use duct tape and aluminum foil to block any areas that have light coming through. For now, do not worry if any light is leaking in from the hole you cut for your head.
9. Once all of the light is blocked, use a pushpin to poke a single hole in the middle of the foil.
10. Now you are ready to test out your pinhole theater! Go outside on a bright day and place the box over your head so that your eyes are facing the screen. Wrap a scarf, blanket, or towel around your neck to block any light that is getting in through your head hole. Wait for your eyes to adjust to the darkness and see if anything appears on the screen. Carefully and slowly move around and observe how the images change!

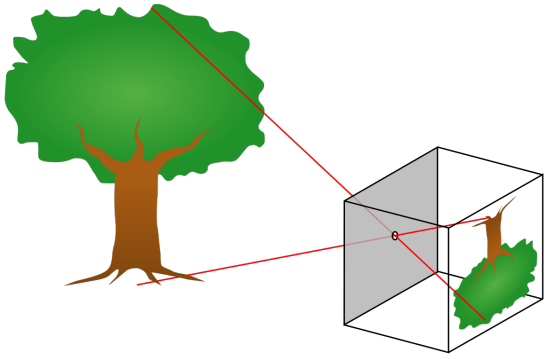


STEM Explanation:

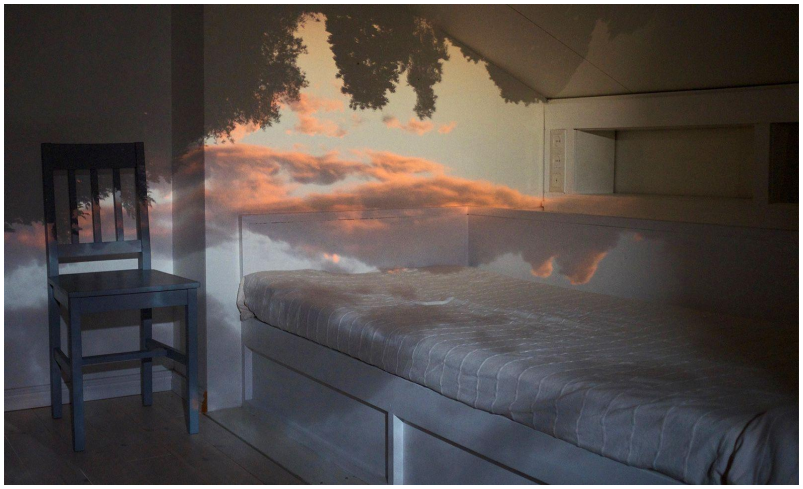
You just created a special version of a pinhole camera! A pinhole camera is the simplest camera possible and is made of a light-proof box, film, and a pinhole — an extremely tiny hole, often made with a pin. Pinhole cameras use this pinhole to focus light rays onto the film and create an image. Let's investigate how this works…

Imagine that you are in the middle of a totally dark room. Then, imagine that you poke a single, tiny hole in the wall and one of your friends shines a bright flashlight through that hole. What will you see inside the room? When you look at the wall that is opposite the pinhole, you will see a small dot created by the flashlight shining through the hole. The smaller the pinhole, the smaller (or, sharper) the dot of light will appear. If your friend angles the flashlight in a different direction, the small dot of light will move as well. This is because, when moving through the air, light travels in a straight path called a ray.

Now, pretend that this pinhole in your wall is facing a very nice landscape scene with trees and a river (and your friend with the flashlight is gone). If you look at the wall opposite the pinhole, you will see an image of this tree and river scene! Each point of the landscape outside emits light rays and, just like the flashlight, the light ray from each point passes through the pinhole and creates a point of light on the opposite wall. Because every single point in the landscape scene does this, an entire image will appear on the wall in your room. However, this image will look upside-down because light particles travel in a straight line through the pinhole. If this is confusing, check out the diagram below, pretending that the tree is part of the landscape, and the box is your room.



A pinhole camera is a smaller version of the room you just imagined, and it uses light-sensitive film to capture the images that are projected on the opposite wall of the pinhole. The pinhole theater you created used a white screen instead of film so that you were able to observe the moving images with your eyes, rather than capturing them in a photo. On the next page, you will see two images of real-life pinhole cameras. The photo on the left shows what it might look like to turn your entire bedroom into a pinhole theater. The photo on the right is of a van-turned-pinhole camera capturing a photo of the Boeing 747 airliner in the background!



Career Connection:

Optical engineers design components of optical instruments such as lenses, microscopes, telescopes, and other equipment that utilize the properties of light.

Resources:

https://electronics.howstuffworks.com/question131.htm
http://www.exo.net/~emuller/activities/personal_pinhole.pdf

Image Sources:
http://www.exo.net/~emuller/activities/personal_pinhole.pdf
https://upload.wikimedia.org/wikipedia/commons/8/81/Pinhole-camera.png
https://www.diyphotography.net/bonfoton-turns-room-camera-obscura/