Pin Hole Cameras & Safely Observing the Sun

Ages: Grades 4-12
Main learning outcome(s):

- Safe solar viewing
- Properties of light
- Projection

Additional learning outcome(s):

- Optics – focal length, aperture

Contents:

Introduction:

Pin hole cameras are an easy and fun way to safely observe the Sun. Use the suggested activities to explore properties of light and projection. Use your pin hole camera(s) anytime to observe the Sun, such as during a partial eclipse.

Equipment:

- Rectangular cardboard box (e.g., cereal box, shoebox)
- Aluminum foil
- Tape
- Toothpick, pushpin, or sewing needle
- Scissors or utility knife
- White paper
- Black Bristol board (optional)
- Flashlight(s) (optional)
- Sequined or other highly reflective clothing (optional)

Diagram 1 - Essential materials for making a pinhole camera.

Building your Pin Hole Camera:

Depending on your students and your classroom, you may be building one pin hole camera together or a group of 2 students may be building one each. We encourage you to make enough pin hole cameras such that there is one for every 2 students.

Identify the smallest sides of your box. This should be one of the sides that is shortest and has the smallest area. There are two of these sides, which we will call the "top" and the "bottom". See Diagram 2 for reference.

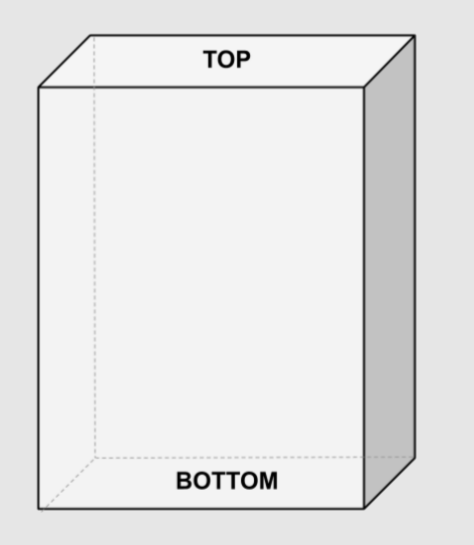

Diagram 2 - A rectangular box with the smallest sides labelled as "Top" and "Bottom".

To build your pin hole camera:

1) Cut two approximately 1cm-by-1cm square holes in the top of your box, on opposite sides of the top face.
2) Tape a piece of white paper to the inside-back of the box (see diagram below). This is where the image will show up!
3) Cut a square of aluminum foil and tape it over one of the holes.
4) Using a toothpick, push pin, or sewing needle, poke a small hole in the aluminum foil.
5) Make sure there are no other holes in the box, cover them up with black paper.

⇒ **Tip:** If your students are not able to handle scissors or sharp implements safely, consider pre-cutting and puncturing the aluminum foil beforehand. Students can then tape and assemble their cameras independently.

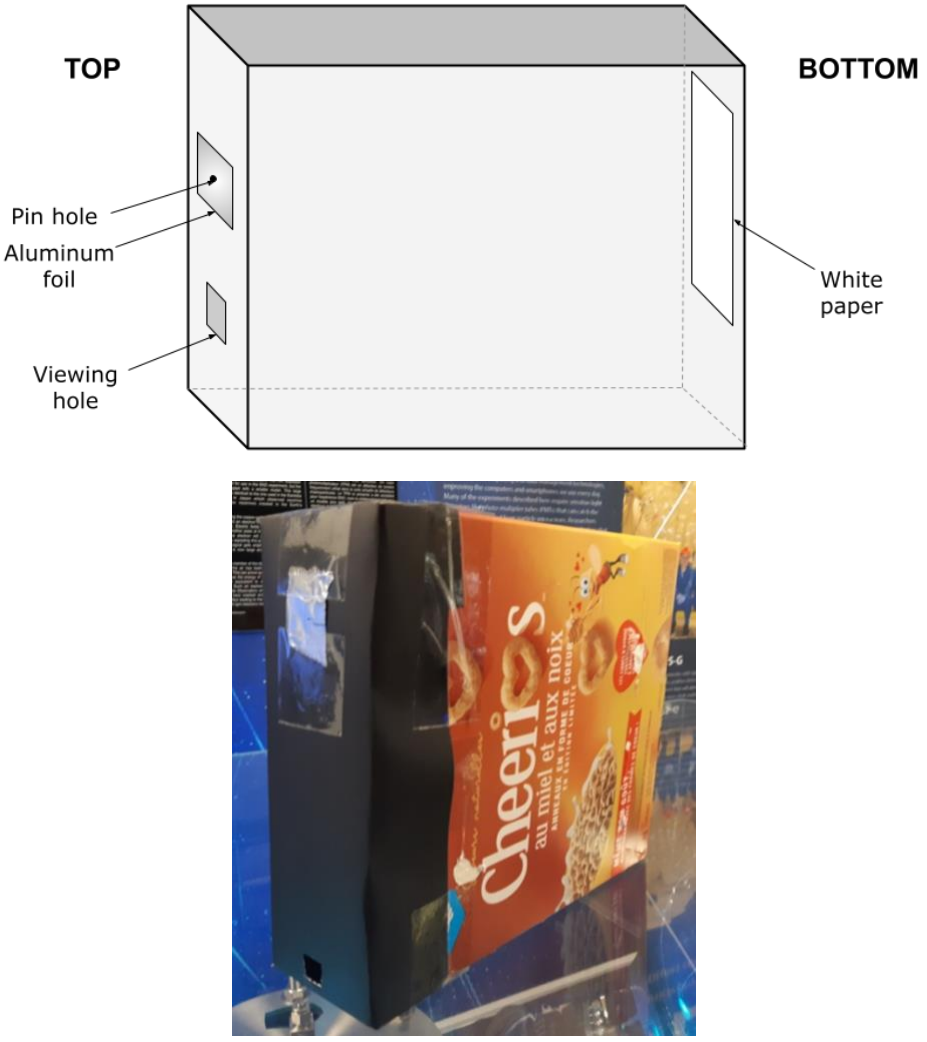

Diagram 3 – A fully constructed pin hole camera. Top figure shows a labelled, transparent diagram and the bottom figure is a photograph of an assembled pinhole camera.

Your pin hole camera is fully assembled!

Test your pin hole camera by looking through the hole not covered by aluminum foil. The pinhole only lets a small amount of light through, so make sure you have something bright to look at. You must look away from the object, just like in Diagram 4.

Observing the Sun:
To observe bright objects, including the Sun, through your pinhole camera, stand facing away from the bright object. Hold your pin hole camera up to your face such that you are looking through the 1cm-by-1cm hole not covered by aluminum foil and the pin hole is in the path of the light. You will see a projection of the Sun on the inside of the bottom of the box.

Diagram 4 – A flashlight pointing towards the pin hole camera, from two perspectives.

Guiding questions:

These questions are great for in-class discussions or can be used as lab report questions. If you decide to use these in a lab setting, consider encouraging students to think about the question, writing down or stating a hypothesis, and if possible, testing out their prediction using the activity equipment. Encourage students to write observations or take photos to document their findings, and if applicable, combine their results in a lab report or written reflection.

1) What do you think you will see if you observe a flashlight beam with the pin hole camera? What do you see? Why?

⇒ **Tip:** Encourage students to look at the flashlight carefully when it is turned off, and to look at what shape the beam creates when pointed at a wall or the ground.
⇒ **Hint:** This depends on the flashlight. Many flashlights do not have a singular beam or bulb but have a central light and a circular piece that reflects and amplifies that light. In this case, a "doughnut" is seen.

2) What do you think you will see if you move two or more flashlights around while observing through the pin hole camera? What do you see? Why?

⇒ **Hint:** The motion of the flashlights will be directly seen in the pin hole camera, move for move.

3) Shine a flashlight onto very reflective material, such as sequins. Can you observe the sequins through the pin hole camera? What does it look like?

⇒ **Tip:** You may need more than one flashlight to make the sequined or reflective clothing bright enough to be seen.

4) Is there a difference in what you see between pin hole cameras that are longer or shorter than others? How do you think the length of a pin hole camera affects what you see, and why?

⇒ **Tip:** Better suited for students in Grade 9 and up, as it relates to optics learning goals. Encourage students to draw light ray diagrams to support their hypotheses and to illustrate their observations.
⇒ **Hint:** The distance from the hole in the top of the box to the screen at the bottom of the box is the focal length of the camera. Pin hole cameras of different lengths will have different focal lengths, but students will find that there isn't much difference in terms of what they are seeing being in focus. The main difference is that a longer focal length will produce a larger image, but it will be dimmer.

5) Make the hole in the aluminum foil for one of the pin hole cameras slightly bigger. Is there a difference in what you see? How does the size of the pin hole affect what you see in a pin hole camera, and why?

⇒ **Tip:** Better suited for students in Grade 9 and up, as it relates to optics learning goals. Encourage students to draw light ray diagrams to support their hypotheses and to illustrate their observations.
⇒ **Hint:** The pin hole is the aperture of the camera. Widening the pin hole will allow more light to enter the pin hole camera, but it will decrease the resolution of the projected image. Thus, a larger pinhole will make the image brighter and blurrier. There is a limit to how small the hole can be before you are trading off increased resolution for diffraction effects, but this is unlikely to occur with home-made pin hole cameras.

6) If you are outside, have one person stand between the Sun and the pin hole camera. If you are inside, have one person shine a flashlight towards the pinhole camera and another stand between the flashlight and the pin hole camera. Make sure that the person's shadow is not falling directly on the aluminum foil. What do you see in the pin hole camera?

⇒ **Tip:** The flashlight beam or Sun needs to be visible around the person standing in front of the pin hole camera. The person should be a few metres away from the flashlight, and a few metres away from the pin hole camera.
⇒ **Hint:** A pin hole camera will always show a projection, and so it will show the shadow of the person but inverted. This is a good opportunity to ask students why the image is inverted.

Additional activities using projection:

What shape is it?

Cut card paper, construction paper, or Bristol board into medium sized cards, at least 10cm square. Draw and then cut with a utility knife a 1cm-by-1cm shape in the centre of each card, including but not limited to a circle, square, triangle, diamond, star, and crescent, such that each card has one shape cut in it.

On a sunny day, hold up the cards one at a time such that the sunlight is passing through the shape of the card onto a flat wall about 1m away. Ask your students what they will see when you hold up the circle card and ask what they see when you do so. Repeat for the other cards.

⇒ **Hint:** No matter what the shape is on the card, the shape of the light on the wall will always be the shape of the Sun (a circle, unless during a partial eclipse). The holes in the cards are acting as an aperture and projecting an image of the Sun.

Resources and More:

There are many magnificent guides on how to make pin hole cameras, including from Kids National Geographic and the Canadian Space Agency. More information on pin hole cameras, their history, and their optics can be found at PinHole.cz. The "What shape is it?" activity is based on the activity by Veritasium.

You can find great eclipse resources and astronomy education resources from Discover The Universe and the Royal Astronomy Society of Canada.

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