Cardboard Box Camera Obscura

Category: Physics: Light & Optics

Type: Make & Take

Rough Parts List:

1	Cardboard box, 12”x12”x12”
	3/8” Plywood
1	73 mm Lens, +2.5 or +3
1	3” Inner diameter cardboard tube
1	5”x7” Mirror
	Black paint
4	Wood screws
	Foam core or cardboard
2	Thick rubber bands

Tools List:

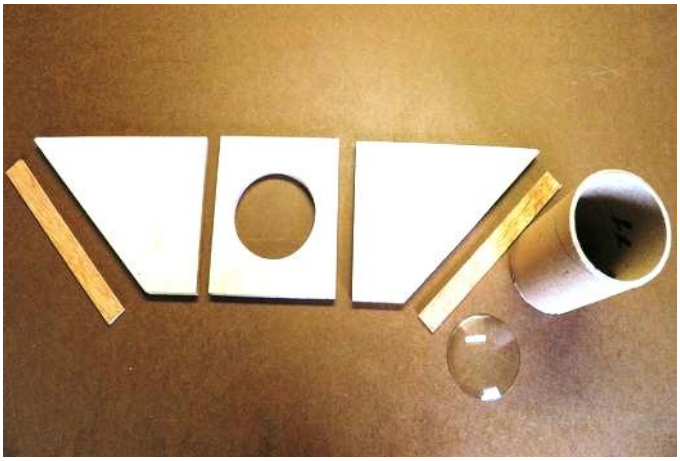
Drill
Paint brush
Hot glue gun
Ruler
Saw
Utility knife

Video: www.youtube.com/user/OaklandCSW

Blog Link: www.oaklanddiscovery.blogspot.com

How To:

Cut plywood into a 5” x 5 ¾” rectangle with a 3¼” hole in the center for the lens holder tube.



Cut pieces for the mirror holder. Cut two 5 ¾”x 5 ¾” squares. Cut a 45 degree angle 2” from one edge on both pieces to create a triangular shape.

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Make two 1” x 7” rail bars from plywood.

Hot glue the sides to base.
The angled side should be pointing upwards.

Drill pilot holes 1” from each glued side and ¼” from bottom.

Drill wood screws into the pilot holes to secure the base.

Glue rails inside the holder about ¼” from the top of the diagonal sides. Rest the mirror on top of the rails and hot glue into place.

Glue four small squares of foam core around the inside of the tube 1¾” from the top of the tube.

Paint the inside of the tube black. Place the lens onto the foam core pieces glued in the tube. Glue four more squares of foam core inside the tube to lock the lens in place.

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Insert lens tube into mirror assembly. Place a large rubber band over the end of the tube to allow the lens holder to move for focusing without falling out.

Draw a 3 ¼" diameter circle in the middle of one side of the box. Cut out the circle with a utility knife. Assemble the box, leaving one end open. Place the side with the circle on top.

Paint the inside of the box black. Hot glue a square of cardboard or scrapwood with a 5 ¾" circle cut out in the center under the exisiting hole for strength.

Set the mirror holder into the hole in the cardboard box. An additional piece of cardboard with a small hold in it can be placed on top of the lens tube to focus the light and create a sharper image.

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→ To focus an image, slide pieces of wood or cardboard between the mirror holder and the box to create different heights.

Place a sheet of white paper inside the box. The mirror will reflect an image onto the paper which can then be traced.

Fine Points:

→ Turn the mirror towards a light source such as an open window for best results.
→ Place a blanket over the open end and viewer when using the camera obscura. This will block out even more light so the image can be seen more clearly.
→ To create a sharper image, you can glue a circular piece of cardboard with a small hole in the center onto the bottom of the cardboard tube. Experiment with the best-sized hole.

Concepts Involved:

- Mirrors reflect light.
- The angle of a mirror determines the angle that light will be reflected.
- Convex lenses create images by bending the path of light from a source.

Focus Questions:

1. What would happen if the mirror was not angled at 45 degrees?
2. Try turning the mirror holder away from you and look at the projected image. What's wrong with the image? Now, try turning the mirror holder towards yourself. Why isn't the image upside down anymore?
3. Why does painting the inside black create a clearer image?

Elaboration:

The cardboard box camera obscura allows the viewer to draw an image captured by the mirror, holder, and lens. Together, those three items work as a simple camera. Light is collected by the mirror and then sent through the lens. The lens projects the image reflected by the mirror onto the piece of white paper in the box. Painting the interior black and covering the open end with a blanket helps block out light that isn't being projected by the lens, making the image clearer.

The mirror in the projector causes the light to reflect, or bounce back. The flat mirror used in this project is called a plane mirror because it reflects light rays in the same order as they approach the mirror. The angle at which the light approaches the mirror is called the angle of incidence. Since the mirror is placed at 45 degrees, the angle of incidence is 45 degrees. Light is reflected from the mirror at an angle called the angle of reflection. The angle of reflection is always equal to the angle of incidence in a mirror.

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Light travels through the lens and hits the wall. A lens is a transparent piece of glass or plastic that has a curved surface. A lens refracts, or bends, light rays as they pass through. The lens you are using has a center that bulges outward; this is known as a convex lens. Convex lenses can create images. The size of the image depends on the distances between the object and lens and between the lens and the screen.

Links to k-12 CA Content Standards:

Grades k-8 Standard Set Investigation and Experimentation:
Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other strands, students should develop their own questions and perform investigations.

Grades k-12 Mathematical Reasoning:
1.0 Students make decisions about how to approach problems:
1.1 Analyze problems by identifying relationships, distinguishing relevant from irrelevant information, sequencing and prioritizing information, and observing patterns.
1.2 Determine when and how to break a problem into simpler parts.

2.0 Students use strategies, skills, and concepts in finding solutions:
1.1 Use estimation to verify the reasonableness of calculated results.
1.2 2.2 Apply strategies and results from simpler problems to more complex problems.
1.3 Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning.
2.5 Indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy.

3.0 Students move beyond a particular problem by generalizing to other situations:
3.1 Evaluate the reasonableness of the solution in the context of the original situation.
3.2 Note the method of deriving the solution and demonstrate a conceptual understanding of the derivation by solving similar problems.
3.3 Develop generalizations of the results obtained and apply them in other circumstances.

Grade 3 Standard Set 2. Physical Sciences:
2.b Students know light is reflected from mirrors and other surfaces.

Grade 7 Standard Set 6. Physical Principles in Living Systems (Physical Sciences):
6.d Students know simple lenses are used in a magnifying glass, the eye, a camera, a telescope, and a microscope.
6.f Students know lights can be reflected, refracted, transmitted, and absorbed by matter.
6.g Students know the angle of reflection of a light beam is equal to the angle of incidence.

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