

PINHOLE CAMERA

OBJECTIVE:

You will understand the principle of the camera obscura and will construct a pinhole camera and use it to demonstrate this principle.

INTRODUCTION:

The first camera was a light-proof room, later to be called a *camera obscura*. In its portable form it was a pinhole camera. A beam of light entered the darkened room through a small hole and an upside-down, reversed image of the view outside was projected onto the opposite wall inside.

This phenomenon was known of as long ago as Archimedes (212–287 BC). The Arab scholar Alhazen (965–1038) used such a camera obscura to observe an eclipse of the sun, and Leonardo da Vinci (1452–1519) described the workings of this camera in detail. Artists used the camera obscura to project images onto canvas that they could then copy. In 1597, an Italian named Giovanni Battista della Porta described the image produced by the camera obscura: "...all things which outside are illuminated by the sun you will see inside, you will see those walking in the street with their heads downwards . . . and the things on the right will appear on the left and all things turned over, and the further they are from the hole, the larger they will appear." In the seventeenth century the first portable type of camera obscura, called a pinhole camera, was made.

It was not until the sixteenth century that lenses were used to improve the brightness and sharpness of the image and focusing was achieved using bellows. During this time, experimentation with chemical solutions and metal plates led to the ability to fix the images produced by the pinhole camera. The first true photographs on light-sensitive metal plates and papers were produced in the 1830s by Jacques Louis Daguerre in France, and by William H.F. Talbot in England.

TIME NEEDED:

1 hour

MATERIALS:

large coffee can
medium-sized, flat-blade screwdriver
small hammer
straight pin
dark cloth at least 1 sq. yd.
sheet of waxed paper
transparent tape

heavy-duty nontransparent tape (e.g., brown plastic packaging tape)
scissors
ruler
adjustable desk lamp with 40-watt bulb (clear with a filament)

Safety Precautions

Please read and copy the safety precautions at the beginning of this book. Be careful when hammering the screwdriver through the base of the coffee can. Do not look directly at the sun through the pinhole camera.

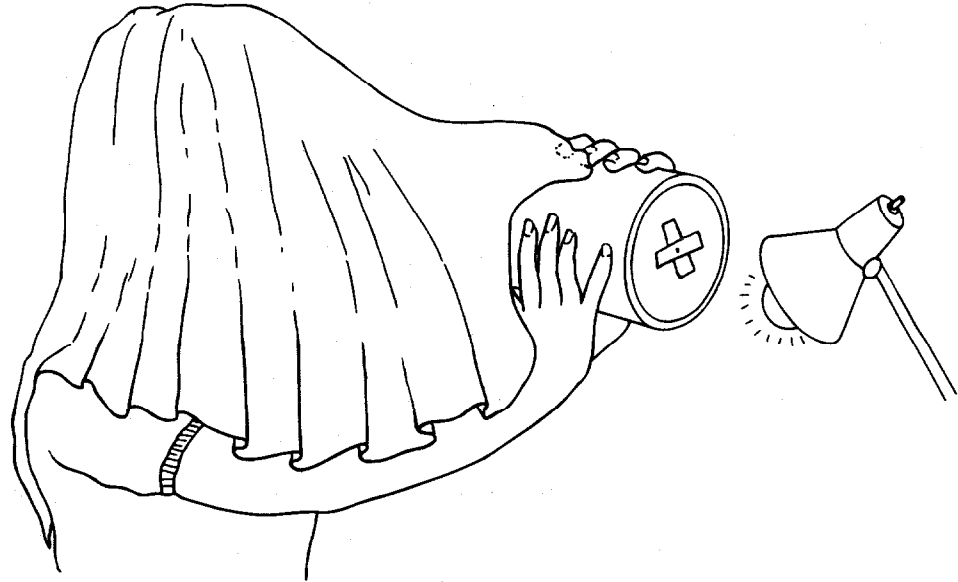
PROCEDURE:

1. Place the coffee can on a table, base end up. Use the hammer and screwdriver to punch a hole in the center of the base of the coffee can. Twist the screwdriver to produce a hole about 1/3 in. across.
2. Cover the outside of the hole with a piece of nontransparent tape.
3. Pierce a hole in the tape using the straight pin.
4. Cut out a circle of waxed paper with a diameter about 1 1/2 in. bigger than the diameter of the coffee can.
5. Pull the waxed paper tight to cover the open end of the coffee can and secure it in place

using transparent tape. This is the viewing screen. Turn on the lamp, and adjust it so that the light bulb is visible.

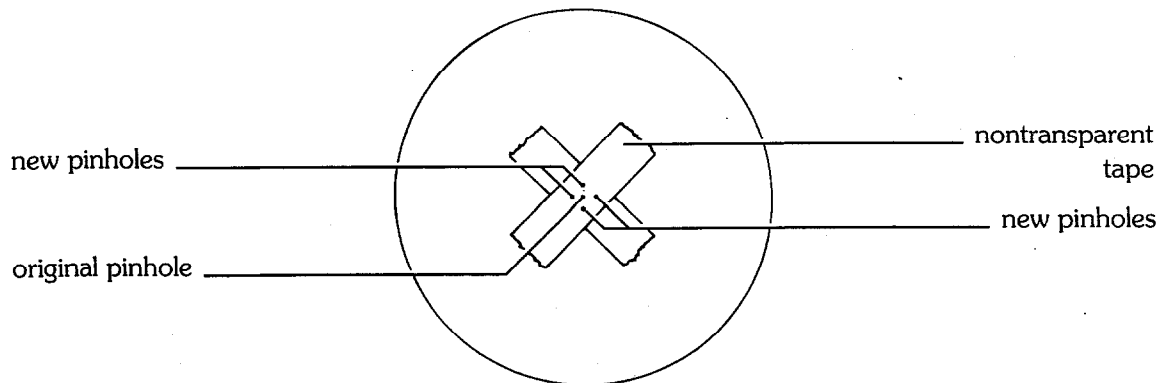
6. Move to about four feet away from the lamp. Cover your head and the end of the coffee can covered by waxed paper with the dark cloth (see figure 1). This will shield the screen from light. Hold the waxed-paper viewing screen at arm's length and aim the pinhole at the light bulb.

Figure 1



7. Record the appearance of the image as seen on the screen.
8. Pierce four pinholes each $\frac{1}{16}$ in. away from the original pinhole, forming a square of five holes with one new pinhole at each corner and the original pinhole in the center (see figure 2).
9. Repeat step 6 and record your findings.
10. Enlarge the size of the original pinhole so that it is at least $\frac{1}{4}$ in. across.
11. Repeat step 6 and record your findings.

Figure 2



ANALYSIS:

1. What happened when you looked through the screen in step 6? Was the image dim or bright? Was it larger or smaller than the bulb you were looking at? Was the image clear or blurred?
2. Describe what happened to the image on the screen when five pinholes were used.
3. Describe what happened to the image on the screen when the original pinhole was enlarged.
4. Do some research. Explain why the image changes when the pinhole is enlarged.
5. How would you easily modify the design of the pinhole camera to use it to make a permanent photographic image?

OUR FINDINGS:

Click on above link to see what we found.

SPECIAL SAFETY NOTE TO INVESTIGATORS

Each invention includes any special safety precautions that are relevant to that particular project. These do not include all of the basic safety precautions that are necessary whenever you are working on a scientific investigation. For this reason, it is absolutely necessary that you read, copy, and remain mindful of the General Safety Precautions that follow this note.

Experimental science can be dangerous, and good laboratory procedure always includes carefully following basic safety rules. Things can happen very quickly when you are constructing or demonstrating a model invention. Things can spill, break, even catch fire. There will be no time after the fact to protect yourself. Always prepare for unexpected dangers by following basic safety guidelines the *entire* time you are carrying out the project, whether or not something seems dangerous to you at a given moment.

We have been quite sparing in prescribing safety precautions for the individual projects. We made this choice for one reason: We want you to take very seriously every safety precaution that is printed in this book. If you see it written here, you can be sure that it is here because it is absolutely critical to your safety.

One further note: The book assumes that you will read the safety precautions that follow, as well as those in the box within each project you are preparing to perform, and that you will *remember* them. Except in rare instances, these precautions will not be repeated in the procedure itself. It is up to you to use your good judgment and pay attention when performing potentially dangerous parts of the procedure. Just because the book does not say **BE CAREFUL WITH HOT LIQUIDS** or **DON'T CUT YOURSELF WITH THE KNIFE** does not mean that you should be careless when simmering water or stripping an electrical wire. It does mean that when you see a special note to be careful, it is extremely important that you pay attention to it.

If you ever have a question about whether a procedure or material is dangerous, wait to perform it until you find out for sure that it is safe.

GENERAL SAFETY PRECAUTIONS

Accidents caused by carelessness, haste, insufficient knowledge, or taking unnecessary risks can be avoided by practicing safety procedures and being alert while carrying out these projects. Be sure to check the individual projects in this book for additional safety regulations and adult supervision requirements. If you will be working in a lab, do not work alone.

PREPARING:

- Clear all surfaces before beginning projects
- Read the instructions before you start
- Know the hazards of the procedures and anticipate dangers

PROTECTING YOURSELF:

- Follow the directions step-by-step; do only one project at a time
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eye wash, and first-aid kit
- Make sure there is adequate ventilation
- Do not horseplay
- Wear an apron and goggles
- Do not wear contact lenses, open shoes, loose clothing, or loose hair
- Keep floor and work space neat, clean, and dry
- Clean up spills immediately
- Never eat, drink, or smoke in laboratory or work space
- Do not eat or drink any substances tested unless expressly permitted to do so by a knowledgeable adult

USING EQUIPMENT WITH CARE:

- Set up apparatus far from the edge of the desk or bench
- Use knives and other sharp or pointed instruments with caution
- Pull plugs, not cords, when removing electrical plugs
- Clean glassware before and after use
- Check glassware for scratches, cracks, and sharp edges
- Clean up broken glassware immediately
- Do not touch metal conductors
- Use only low voltage and current materials such as lantern batteries
- Be careful when using stepstools, chairs, and ladders
- Never look directly at the sun with your observation devices

USING CHEMICALS:

- Never taste or inhale chemicals
- Label all bottles and apparatus containing chemicals
- Read labels carefully
- Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves)
- Do not touch chemical solutions
- Wash hands before and after using solutions
- Wipe up spills thoroughly

HEATING SUBSTANCES:

- Use goggles, apron, and gloves when boiling water
- Keep your face away from test tubes and beakers
- Never leave apparatus unattended
- Use safety tongs and heat-resistant mittens
- Turn off hot plates, bunsen burners, and gas when you are done
- Keep flammable substances away from heat
- Have fire extinguisher on hand

FINISHING UP:

- Thoroughly clean your work area and glassware
- Be careful not to return chemicals or contaminated reagents to the wrong containers
- Don't dispose of materials in the sink unless instructed to do so
- Wash your hands
- Clean up all residue and put in proper containers for disposal
- Dispose of all chemicals according to all local, state, and federal laws

BE SAFETY CONSCIOUS AT ALL TIMES