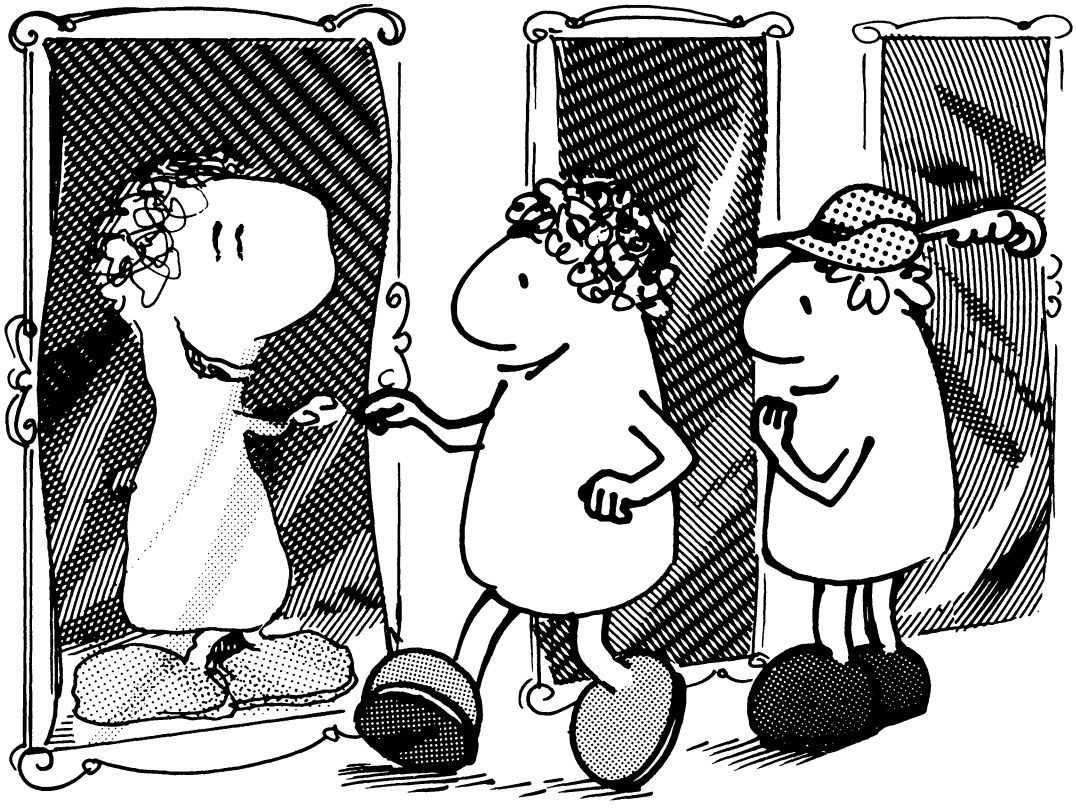
LIGHT



TASK CARD SERIES

Conceived and written by
RON MARSON

Illustrated by
PEG MARSON

TOPS LEARNING SYSTEMS

10970 S Mulino Road
Canby OR 97013
Website: topscience.org
Fax: 1 (503) 266-5200

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INTRODUCTION

TEACHING NOTES

REPRODUCIBLE STUDENT TASK CARDS

Gathering Materials

Listed below is everything you'll need to teach this module. You already have many of these items. The rest are available from your supermarket, drugstore and hardware store. Laboratory supplies may be ordered through a science supply catalog.

Keep this classification key in mind as you review what's needed:

special in-a-box materials: Italic type suggests that these materials are unusual. Keep these specialty items in a separate box. After you finish teaching this module, label the box for storage and put it away, ready to use again the next time you teach this module.	general on-the-shelf materials: Normal type suggests that these materials are common. Keep these basics on shelves or in drawers that are readily accessible to your students. The next TOPS module you teach will likely utilize many of these same materials.
(substituted materials): Parentheses enclosing any item suggests a ready substitute. These alternatives may work just as well as the original, perhaps better. Don't be afraid to improvise, to make do with what you have.	*optional materials: An asterisk sets these items apart. They are nice to have, but you can easily live without them. They are probably not worth an extra trip to the store, unless you are gathering other materials as well.

Everything is listed in order of first use. Start gathering at the top of this list and work down. Ask students to bring recycled items from home. The teaching notes may occasionally suggest additional student activity under the heading "Extensions." Materials for these optional experiments are listed neither here nor in the teaching notes. Read the extension itself to find out what new materials, if any, are required.

Needed quantities depend on how many students you have, how you organize them into activity groups, and how you teach. Decide which of these 3 estimates best applies to you, then adjust quantities up or down as necessary:

$Q_1 / Q_2 / Q_3$

- **Single Student:** Enough for 1 student to do all the experiments.
- **Individualized Approach:** Enough for 30 students informally working in 10 lab groups, all self-paced.
- **Traditional Approach:** Enough for 30 students, organized into 10 lab groups, all doing the same lesson.

KEY: *special in-a-box materials* (substituted materials) general on-the-shelf materials *optional materials

1/1/1	*packet powdered milk (fresh milk)*
1/1/1	source of water
1/10/10	baby food jars
1/10/10	*dark-colored cloth towels*
1/10/10	flashlights with two fresh D cells — ask students to bring these from home.
1/1/1	roll aluminum foil.
1/6/10	rolls masking tape
2/20/20	*rectangular pocket mirrors without frames*
2/20/20	empty tin cans — medium 15 or 16 oz size
1/1/1	roll waxed paper
4/40/40	medium-sized rubber bands
3/30/30	straight pins
1/10/10	scissors
1/10/10	*empty cereal boxes*
3/30/30	size-D batteries, dead or alive
5/50/50	4x6 inch index cards
5/50/50	paper clips
1/2/5	paper punch tools
1/1/1	spool thread
2/20/20	pennies
10/100/100	sheets notebook paper
5/50/50	straight plastic drinking straws
2/6/20	*bathroom hand mirrors with plane surfaces*
4/40/40	microscope slides
1/6/10	*rectangular cake pans — about 9 by 12 inches or 20 x 30 cm*
1/6/10	eyedroppers
1/4/10	empty tuna fish cans or equivalent size
2/8/20	small test tubes
4/40/40	hand lenses with rigid handles — see notes 18 for recommendations
1/4/10	*transparent plastic pill vials — see notes 19
1/4/10	**prisms — see notes 20*
1/4/10	white plates (paper plates)
1/1/1	*sheets each of blue and yellow cellophane (clear plastic report covers)*
2/20/20	textbooks of equal size
1/1/1	roll plastic wrap
1/4/10	ball point pens
1/5/10	rolls clear tape
1/6/10	canning rings
1/4/10	spoons
1/10/10	facial tissues (soft toilet tissues)

Sequencing Task Cards

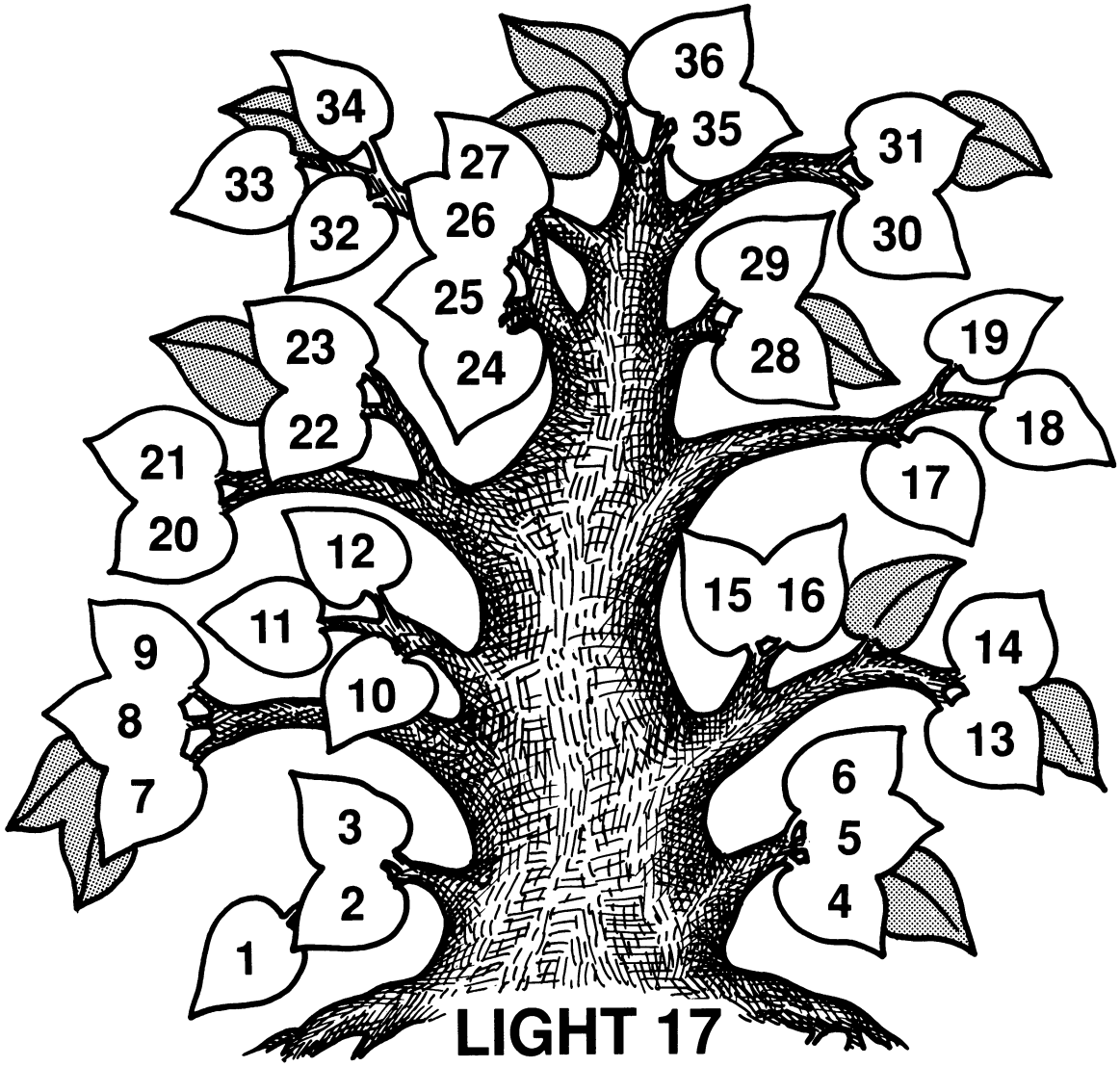
This logic tree shows how all the task cards in this module tie together. In general, students begin at the trunk of the tree and work up through the related branches. As the diagram suggests, the way to upper level activities leads up from lower level activities.

At the teacher's discretion, certain activities can be omitted or sequences changed to meet specific class needs. The only activities that must be completed in sequence are indicated by leaves that open *vertically* into the ones above them. In these cases the lower activity is a prerequisite to the upper.

When possible, students should complete the task cards in the same sequence as numbered. If time is short, however, or certain students need to catch up, you can use the logic tree to identify concept-related *horizontal* activities. Some of these might be omitted since they serve only to reinforce learned concepts rather than introduce new ones.

On the other hand, if students complete all the activities at a certain horizontal concept level, then experience difficulty at the next higher level, you might go back down the logic tree to have students repeat specific key activities for greater reinforcement.

For whatever reason, when you wish to make sequence changes, you'll find this logic tree a valuable reference. Parentheses in the upper right corner of each task card allow you total flexibility. They are left blank so you can pencil in sequence numbers of your own choosing.



LIGHT 17

Review / Test Questions

Photocopy the questions below. On a separate sheet of blank paper, cut and paste those boxes you want to use as test questions. Include questions of your own design, as well. Crowd all these questions onto a single page for students to answer on another paper, or leave space for student responses after each question, as you wish. Duplicate a class set and your custom-made test is ready to use. Use leftover questions as a review in preparation for the final exam.

task 1

How does a pea shooter (a straw through which you blow peas) model a flashlight?

task 2-3 A

Looking directly at the sun (during an eclipse or any other time) can cause irreversible damage to the retina of your eye. Explain how to use a pinhole to safely watch the sun.

task 2-3 B

As you change the distance between a pinhole viewer and an object, how does the size of the image change? Illustrate your answer with diagrams.

task 4-5 A

The shadow of the monster looms larger and larger against the castle wall. How is this monster moving relative to the wall and the light source? Use diagrams to support your answer.

task 4-5 B

Which projects a clearer shadow of your hand against a wall — a small pen light or a large lantern? Use the terms umbra and penumbra in your answer.

task 6

You are observing (in a safe manner) an eclipse of the sun. Draw how the sun appears if you...
a. stand in twilight.
b. stand in total darkness.
c. notice almost no darkness at all.

task 7

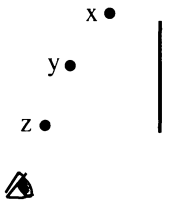
You are adrift in a tiny raft at sea. Just before sunset you spot a search plane high overhead. You grab a hand mirror from your emergency pack and feverishly try to signal up an SOS. How should you hold the mirror?

task 7-10

Accurately sketch the virtual image of this arrow behind the mirror. Explain how your drawing illustrates that $\angle i = \angle r$.

task 11

Can the observer see each point x, y and z reflected in the mirror? Illustrate your answer with a diagram.



task 12

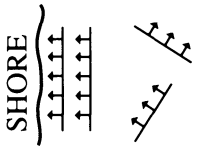
How could you use a piece of glass to create the illusion of a candle flame burning inside a jar of water?

task 13

How does water dripping into a full tub model a light bulb shining in a room?

task 14-16

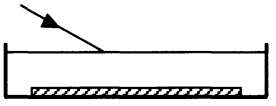
Ocean waves may move in a variety of directions far from land, but generally form wave fronts parallel to the shore when near land.



a. Explain why this happens.
b. How does this model the refraction of light?

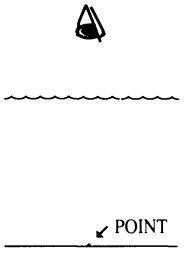
task 7, 16

Trace the path of this ray as it refracts between air and water and reflects off the mirror.



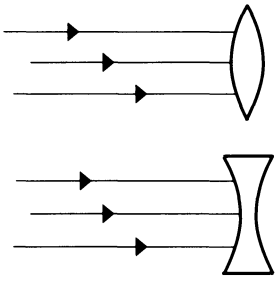
task 17

Complete this diagram to explain why each point at the bottom of a swimming pool appears to be more shallow than it really is.



task 18, 24

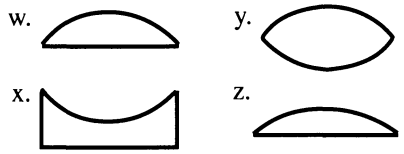
Show how sunlight passes through each lens. Label the concave lens, the convex lens, converging rays, diverging rays and the focal point.



Review / Test Questions (continued)

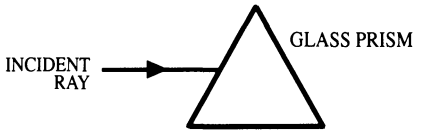
task 18, 24, 30

Which of these lenses...
a. has no focal point?
b. has the longest focal length?
c. has the shortest focal length?
d. magnifies the most?



task 19

Diagram at least 2 points of refraction and 2 points of reflection for the incident light ray.



task 20

The same spot on a diamond ring flashes many different colors as you gently rock it back and forth on your finger in sunlight. How is this possible?

task 20-21

Is white a real color in the same sense that red and blue are real colors?

task 21

When *paint* is mixed:
blue + yellow = green.
When *light* is mixed:
blue + yellow = white.
How can this be?

task 22-27

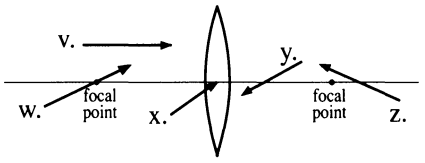
What is the difference between...
a. a concave lens and a convex lens?
b. a focal point and a focal length?
c. a real image and a virtual image?

task 22-23

You are given a magnifying glass. Describe 2 different ways to measure its focal length.

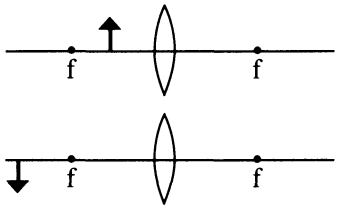
task 24

For each incident ray below, describe its emerging path on the opposite side of the lens.



task 24-26

Use ray diagrams to find the image of each object arrow.



task 25-27

Where must an object be located so the image formed by a hand lens is...
a. virtual
b. real
c. inverted and enlarged
d. inverted and reduced
e. inverted, but the same size

task 28-29 A

Does a microscope form a virtual image? A real image? Explain.

task 28-29 B

How is a telescope similar to a microscope? How are they different?

task 30

Look at something far away, then at something close. What does your eye do to allow you to see both images clearly? Illustrate your answer with diagrams.

task 31-32

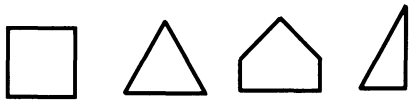
How is a tiny pinhole poked in foil like a hand lens? How is it different?

task 33

You are assigned to paint the word FIRE on the front of a truck so other drivers can recognize the word when looking into their rearview mirrors. Draw how it should look. Use a mirror if you want to.

task 34

Draw in all lines of symmetry for each figure. Use a mirror if you wish.



task 35-36

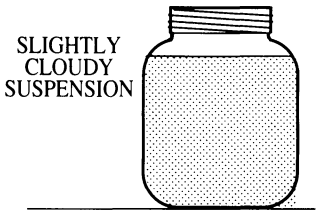
A hand lens reflects back 2 images of a candle flame.
a. What part of the lens forms each image?
b. Which image is virtual and which is real? How could you prove your answer?

Task Objective (TO) observe the path of light beams in a colloidal suspension. To understand light beams in terms of the particle nature of light.

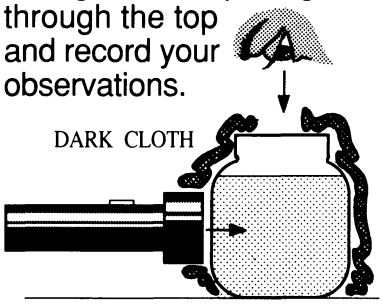
LIGHT AS PARTICLES

Light ( )

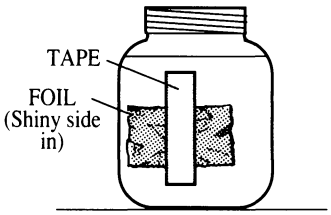
1. Add a *tiny* pinch of powdered milk to a small jar of water. Shake it vigorously. It should look only slightly cloudy.



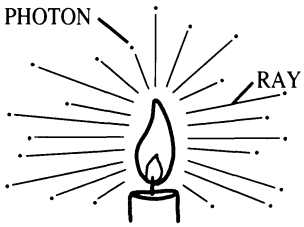
2. Wrap the jar in a dark cloth while shining a flashlight through a small opening. Look through the top and record your observations.



3. Tape a piece of foil to the jar, shiny side in. Repeat the experiment, directing the beam through the water at the foil. What do you see?



4. It is useful to think of light as composed of incredibly tiny, fast moving particles (*photons*). How do these photons appear to move?



5. The path a light photon takes is called a *ray*. Draw a light ray diagram to illustrate why you can't see your ear without a mirror.

1

Answers / Notes

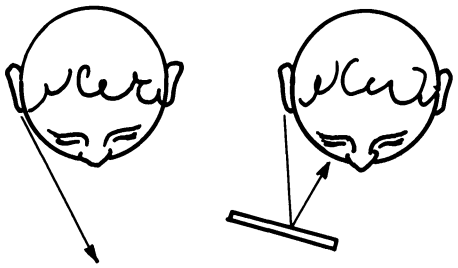
1. *The water should look only slightly cloudy, remaining essentially transparent.*

2. A straight beam of light cuts through the milky suspension.

3. The light beam reflects off the foil, deflecting along a new straight path.

4. Photons seem to move along straight lines. When they hit shiny aluminum foil they are able to bounce off, reflecting along a new straight line. *(The particle nature of light presented here is balanced by a presentation of light as waves in activity 13.)*

5.

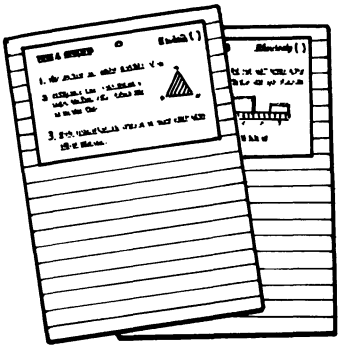


Materials

- ☐ Powdered milk. A drop of fresh milk will also serve.
- ☐ A source of water.
- ☐ A small beaker or jar. Baby food jars, used widely in this module, are ideal.
- ☐ A dark-colored towel or cloth.
- ☐ A flashlight.
- ☐ Aluminum foil.
- ☐ Masking tape.
- ☐ A plane mirror (optional).

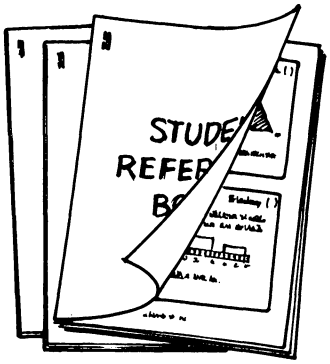
Task Cards Options

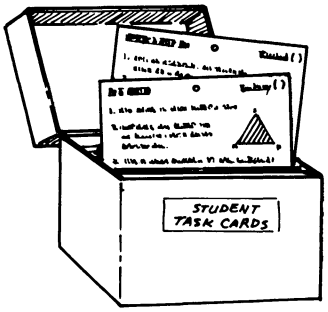
Here are 3 management options to consider before you photocopy:



1. Consumable Worksheets: Copy 1 complete set of task card pages. Cut out each card and fix it to a separate sheet of boldly lined paper. Duplicate a class set of each worksheet master you have made, 1 per student. Direct students to follow the task card instructions at the top of each page, then respond to questions in the lined space underneath.

2. Nonconsumable Reference Booklets: Copy and collate the 2-up task card pages in sequence. Make perhaps half as many sets as the students who will use them. Staple each set in the upper left corner, both front and back to prevent the outside pages from working loose. Tell students that these task card booklets are for reference only. They should use them as they would any textbook, responding to questions on their own papers, returning them unmarked and in good shape at the end of the module.



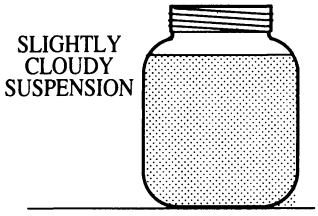


3. Nonconsumable Task Cards: Copy several sets of task card pages. Laminate them, if you wish, for extra durability, then cut out each card to display in your room. You might pin cards to bulletin boards; or punch out the holes and hang them from wall hooks (you can fashion hooks from paper clips and tape these to the wall); or fix cards to cereal boxes with paper fasteners, 4 to a box; or keep cards on designated reference tables. The important thing is to provide enough task card reference points about your classroom to avoid a jam of too many students at any one location. Two or 3 task card sets should accommodate everyone, since different students will use different cards at different times.

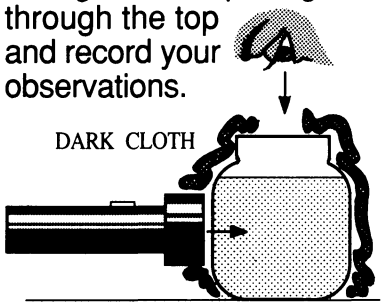
LIGHT AS PARTICLES

Light ( )

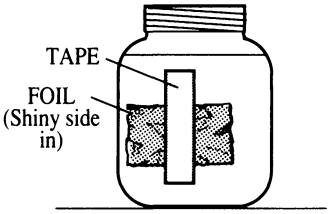
1. Add a *tiny* pinch of powdered milk to a small jar of water. Shake it vigorously. It should look only slightly cloudy.



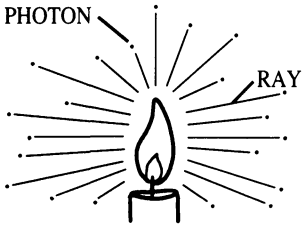
2. Wrap the jar in a dark cloth while shining a flashlight through a small opening. Look through the top and record your observations.



3. Tape a piece of foil to the jar, shiny side in. Repeat the experiment, directing the beam through the water at the foil. What do you see?



4. It is useful to think of light as composed of incredibly tiny, fast moving particles (*photons*). How do these photons appear to move?

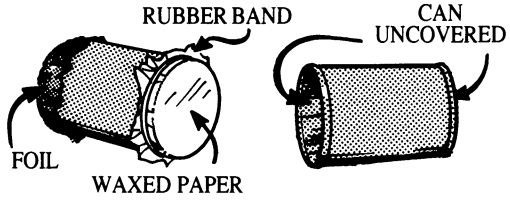


5. The path a light photon takes is called a *ray*. Draw a light ray diagram to illustrate why you can't see your ear without a mirror.

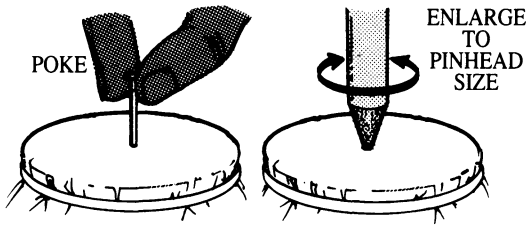
PINHOLE VIEWER (1)

Light ( )

1. Get 2 tin cans of equal size with both ends removed. Cover just one with foil at one end, and rubber band waxed paper to the other end.

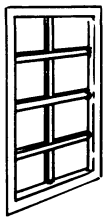


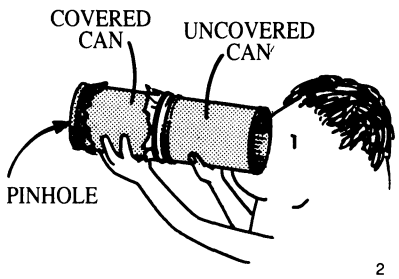
2. Poke a pinhole in the center of the foil. Enlarge it to the size of a pin head with a sharp pencil point.



3. Hold the uncovered can over the waxed paper end, while looking through it toward a well-lit area.

   a. Write your observations.
   b. Is the pinhole image erect (right-side-up) or inverted (upside-down)?
   c. Draw a labeled light ray diagram to explain your observations.





Save your pinhole viewer to use again.