SUGGESTED ACTIVITIES

(*Light*)

From *Invitations to Science Inquiry 2nd Edition* by Tik L. Liem:

Activity	Page Number	Concept
Make a Pinhole Camera	271	Light Travels in a Straight Line
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From *Harcourt Science* Teacher's Ed. Unit E: (For ALL grade levels)

Activity	Page Number	Concept
How Light Travels	F33(3rd grade text)	Light
Making a Rainbow	F43(3rd grade text)	Refraction
Colors	F51(3rd grade text)	Reflection, Absorption
Make a Periscope	F51(3rd grade text)	Reflection

MAKE A PINHOLE CAMERA

A. Question: *How does light travel?*

B. Materials Needed:

1. A shoebox
2. Onion skin paper (thin paper).
3. A candle.

C: Procedure:

1. Take the shoebox and cut out the side of one end of the box and tape the thin onion skin paper to it.
2. Make a small round hole in the other end of the box and tape the lid to the box. (Make the hole a little larger than a pin hole).
3. Point the hole-end of the box towards a window or a light source: lamp or candle, and observe the image on the thin paper (prevent light from falling on the outside of the onion skin paper).

D: Anticipated Results:

Students should observe the formation of an inverted image on the onion skin paper.

E: Thought Questions for Class Discussion:

1. What do you observe on the onion skin paper?
2. Why is the image on the paper always upside down?
3. What would happen to the image if the pinhole were enlarged?
4. How do the light rays travel from the object to the image?

F: Explanation:

Light travels in straight lines. This is why image is always inverted. The light from point A of the object travels in a straight line through the pinhole to point A’ on the onion skin of the box, and point B to point B’, thus inverting the image. When the pin hole is enlarged, the image will get blurred. The smaller the hole (aperture in camera), the sharper the image.

The onion skin paper at the end of the box may be replaced with a photographic plate and exposed for a short time. (The box has to be held steady).

FUNNY REFLECTIONS

A. Question: *What is symmetry?*

B. Materials Needed:

1. Unframed square or rectangular mirror (for each pair of students).

C: Procedure:

1. Print the following words each on a separate piece of blank paper in large, even, capital letters. CHEEK, BIKE, DECIDE, BOX, CHICK, CHOKE, BOOK, HIDE, CODE, DOCK, COOKIE.
2. Cut each piece of paper in half, right through the middle of each word printed, leaving the lower half of the word on the paper.
3. Now place the mirror vertically against the paper (perpendicular on the table) and look in the corner of the paper and the mirror.
4. Do this for each one of the words.

D: Anticipated Results:

Students should observe which letters are symmetrical.

E: Thought Questions for Class Discussion:

1. Will this work with any printed word?
2. Which of the letters, when cut in half, will appear whole with the mirror above it?
3. Which letters, when cut in half vertically, will give the other half in the mirror, when the half letter is held against it?

F: Explanation:

This activity will provide the student with the ability to recognize symmetrical objects and printed letters. It gives the student an opportunity to manipulate spatial relations. The image in the mirror shows that all images are actually formed behind the mirror. It is only with the letters: B, C, D, E, H, I, K, O and X, that the above activity can be carried out. All other letters will not give the upper half in the mirror. The following can be cut vertically in half and the other half will show up in the mirror, when held against it: A, H, I, M, O, T, U, V, W and X, Y. This activity gives the students an idea of **symmetry** and **symmetrical shapes.**

THE SWOLLEN FINGER

A. Question: *What factors affects a magnifying lens?*

B. Materials Needed:

1. A plastic vial (about 2cm diameter). An olive jar is quite suitable.

C: Procedure:

1. Fill the vial or jar about ¾ full with water.
2. Immerse your forefinger in the water and compare the difference in size with the others fingers that are out of the water.
3. Pour out the water and compare the size of the fingers again without the water in the vial.

D: Anticipated Results:

Students should observe magnification of their forefinger when it is immersed in the water.

E: Thought Questions for Class Discussion:

1. Why does the forefinger look so much larger than the other fingers?
2. Did the finger look larger without the water in the vial?
3. What is the basic cause for magnification?
4. Would we get magnification by looking through a rectangular jar?
5. What other liquids can we use in the vial?

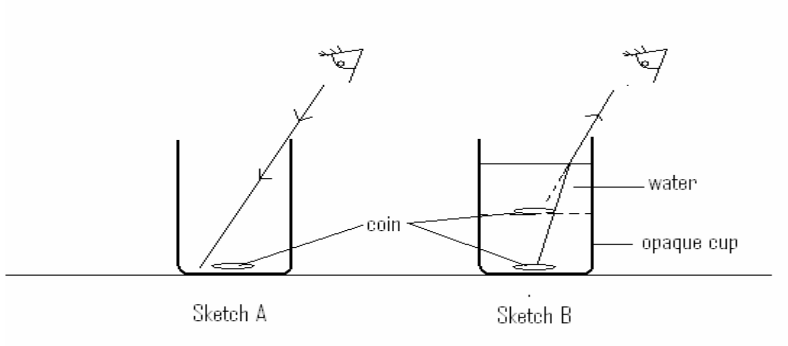
F: Explanation:

The basic reason why the finger looks so much larger is that the water in the vial acts like a magnifying lens. The shape of the vial resembles the shape of a convex lens. If the container were flat rectangular container, this lens effect would be lost.

The material inside the container may be compared with the glass, which the magnifying lens is made of. Other materials that have high **refraction indices** may be used to obtain this same effect.

THE REAPPEARING COIN

A. Question: *Does the medium through which light travels affect the way light rays are refracted?*



B. Materials Needed:

1. An opaque cup (foam or polystyrene).
2. A coin (or any small object that sinks in water).

C: Procedure:

1. Let the students gather around the cup placed on a low stool.
2. Place a coin in the opaque cup and let the students move their heads down from where they can see the coin, so that they just cannot see it (because it disappears behind the rim of the cup), and let them hold their eyes steady at the spot (the coin may be taped to the bottom of the cup, so it won't slide when the water is poured in).
3. Pour water into the cup until it is almost full: coin reappears!

D: Anticipated Results:

Students be able to see the coin that was placed inside the cup after water is poured into the cup.

E: Thought Questions for Class Discussion:

1. What made the coin disappear before the water was poured?
2. What made the coin reappear?
3. Did you have to move the position of your eyes to see the coin again?
4. What can you tell about the path of the light rays coming from the coin?
5. What other liquids can be used instead of water?

F: Explanation:

The eyes were positioned, such that the light rays coming from the coin were blocked by the rim of the cup. By adding water to the cup, theses same light rays from the coin, now are **refracted away from the normal,** as it travels from a medium with larger to a medium with smaller refractive index.

The **normal** is the line perpendicular to the surface separating the two media through which light ray travels. Other liquids with high refractive indices, usually the denser ones, may replace water in this case. This phenomenon is the reason why some deep waters seem to look shallow.

THE INVISIBLE PENNY

A. Question: *Can water bend light rays?*

B. Materials Needed:

1. Two regular drinking glasses.
2. A small saucer and a penny (or other coin).

C: Procedure:

1. Fill one of the glasses almost full with water.
2. Cover the empty glass with the saucer and place the covered glass on the coin. Let the students observe the coin **only** from the side of the glass.
3. Fill this glass with water, tilting the saucer towards the observing students, and place back the saucer.
4. Ask students: “Where did the penny go?” Move the glass to the side and reveal the penny.

D: Anticipated Results:

Students should not be able to observe the penny when the glass if filled with water.

E: Thought Questions for Class Discussion:

1. What made the penny or coin invisible?
2. Where do the light rays of the coin travel?
3. Why do we need a saucer to cover the glass?
4. Why does the saucer have to slant towards the observer?
5. What other objects may be used in place of the coin?

F: Explanation:

The coin is still visible with the empty glass and saucer on top of it, because the light rays are not refracted by the air filled glass, and the coin can be seen from the side of the glass. By filling the glass with water, the material through which the rays are traveling is denser and thus, when they hit the side of the glass they are being totally reflected or refracted very closely to the side of the glass. The saucer on top of the glass prevents seeing these rays and thus seeing the coin. The saucer has to be tilted towards the observer, while filling the glass with water, for the same reason.

Other objects in place of the coin would be, anything which is flat and thin, and that can be covered by the bottom of the glass; like a stamp, a thin button, a piece of paper, etc.

THE WATERDROP MAGNIFIER

A. Question: *Can water be used as a magnifying lens?*

B. Materials Needed:

1. A roll of wax paper.
2. A small cup.

C: Procedure:

1. Tear off about 10cm wide strips of wax paper from the roll and distribute this to each student or to each pair of students.
2. Let the students place the wax paper over small print of anything small that they want to see magnified.
3. Come around with water in a cup and put a drop on the wax paper, make a circle about ½ cm in diameter.
4. Let the students try out drops with different diameters.

D: Anticipated Results:

Students should observe magnification of the small print after placing a drop of water on the wax paper.

E: Thought Questions for Class Discussion:

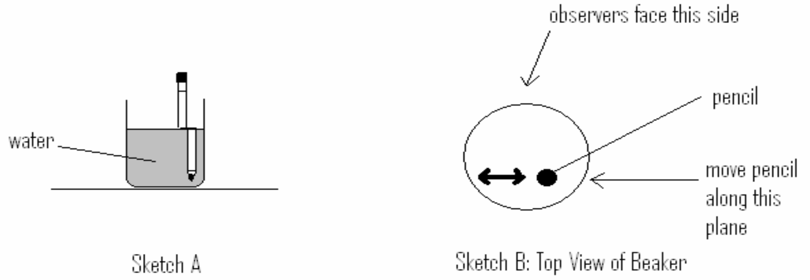
1. How can a water drop act as a magnifier?
2. Which drop magnifies better, the smaller or the larger?
3. What property of the drop makes the amplification larger or smaller?
4. What other material could we use to replace the wax paper?

F: Explanation:

The water drop on the wax paper stays rounded on the top **(convex)** because of the water-repellent properties of the paper **(hydrophobe).** This is why the water drop resembles the shape of a magnifying glass. The smaller the water drop, the stronger the curvature, in other words, the more curved the upper surface is, and thus the stronger the magnification. Any other material that is translucent and hydrophobe may be used to replace the wax paper. If wax paper is not available, overhead transparencies or glass sheets may be used. Regular writing paper might be used which is made translucent.

THE BROKEN PENCIL

A. Question: *How can refracted light rays affect the way we see an object?*



B. Materials Needed:
1. A medium size beaker or glass jar.
2. A pencil (or a pen or straw).

C: Procedure:
1. Fill the beaker or jar about 2/3 full with water.
2. Take a pencil, pen or straw and immerse it vertically about halfway into the water, and say to the students: “I have now broken the pencil (pen or straw).”
3. Move the pencil back and forth along a vertical place somewhat closer to the demonstrator and parallel to the observer’s eyes.

D: Anticipated Results:

Students should have the impression that the pencil is broken when placed vertically in the water.

E: Thought Questions for Class Discussion:
1. Is the pencil actually broken?
2. Why does the pencil look like it is broken?
3. Would we get the same effect without the water?
4. What other liquids can be used for this demonstration?
5. What other objects can we use to immerse?

F: Explanation:

The light rays from the pencil travel from a denser medium (water) to a less dense medium (air). This makes the light ray reflect away from the normal, and the pencil is seen at the extension of the refracted ray.

When the pencil is in the center of the beaker, the ray is not refracted, because the light ray is traveling along the normal. Sketch 3 shows the light ray from the pencil on the opposite side of the beaker.

MAKE RAINBOW COLORS

A. Question: *Are different colored light rays bent the same when passing through a prism?*

B. Materials Needed:
1. A triangular prism glass.
2. A blank piece of paper and sun rays.

C: Procedure:
1. Place a blank sheet of paper on the table top where the sun rays shine through the window.
2. Hold a triangular glass prism in the sun rays and turn it around its lengthwise axis until rainbow spectrum falls on the blank paper.

D: Anticipated Results:

Students should observe that the violet rays are bent the most.

E: Thought Questions for Class Discussion:
1. How can white light give the colors of the rainbow?
2. What are the colors of the rainbow?
3. Which color is bent most? (Farthest away from the straight line?)
4. What source can we use instead of sun rays?

F: Explanation:

White light is mad up of rainbow colors: violet, blue, green, red, yellow and orange. The violet is refracted or bent the most, and the red is bent the least. This is why the sky stays blue when the sun sets in the west and becomes red. The moisture in the atmosphere would act as prisms and scatter or separate the blue light out. Viewing the sun rays from a 90 degree angle, the color will appear blue, whereas looking directly into the setting sun, the color is red.

THE CONFUSED FLASHLIGHT

A. Question: *Can light rays change color?*

B. Materials Needed:

1. A strong flashlight.
2. A large beaker, medicine dropper and stirrer.
3. A few milliliters of regular cow milk.

C: Procedure:

1. With the medicine dropper, place one drop at a time of milk in the water and stir.
2. After each drop of milk added to the water, shine the flashlight through the water Fill the beaker nearly full with water.
3. By holding it on the side of the beaker: let the light beams shine perpendicular to and into the student's view.
4. Keep adding the drops of milk to the water until the light shone into the student's view becomes red.

D: Anticipated Results:

Students should observe a change in color of the light rays after adding milk to the water.

E: Thought Questions for Class Discussion:

1. What made the color of the light change?
2. What purpose does the milk have?
3. If the water were the earth's atmosphere and the flashlight were the sun, what can the milk droplets de equated to?

F: Explanation:

Increasing the milk droplets in the water is like increasing the water and dust particles in the atmosphere. When the sun moves to the west approaching sunset, the atmosphere through which we are looking is much thicker. This means that we are actually looking through more dust and water particles. When we look to the west during sunset, we look directly into the sun rays, seeing the sun as a red ball. Looking up towards the sky when the sun is in the west, still leaves the sky blue. The sun rays are now perpendicular to the direction of our view. This difference in color is caused by the refraction of the blue light. The shorter the wavelength (blue), the more it is bent or refracted by milk droplets. The light with the longer wavelength (red) is not as much refracted and this is why the light from the flashlight is red when we look directly into it.