

Eighth Grade Physics

Optics Experiments

#1 The Aquarium

Equipment : 1 aquarium, filled two-thirds with water.

Procedure : Make careful observations.

Considerations for Observation : Don't pay attention to reflections. Pay close attention to the distortion of the aquarium's shape, and how things behind the aquarium appear when looking through the water. Make a drawing that *accurately* shows how the aquarium appears looking fairly close to the front side. Pay special attention to the edges.

#2 Objects in Water

Equipment : 1 plastic dishwashing basin; 1 ruler; 1 coin; 1 cube

Procedure : Submerge the coin and the cube in the basin, which should be nearly completely filled with water. Hold or secure the ruler so that it is slightly off vertical, thereby balancing on a point. All three objects should be next to one another at the end of the basin.

Observe the objects from the other end of the basin. Look straight down at them and then look at them at a sharp angle, such that your eye is close to water level.

Considerations for Observation : What do you observe as the viewing angle changes from 90 degrees (perpendicular to the surface) to 0 degrees (parallel to the surface)?

#3 Looking Through a Prism

Equipment : 1 small glass prism for each person.

Procedure : Closing one eye, hold the prism horizontally in front of the other eye. You should hold the prism so that only the thumb and forefinger are touching the ends of the prism. It may be helpful to rotate the prism slightly.

Considerations for Observation : Pay special attention to how shapes are changed and to colors that appear in unexpected places.

#4 The Reappearing Coin

Equipment : 1 bowl; 1 coin; 1 pencil; a jug of water.

Procedure : Place the coin in the center of an empty bowl. Everyone in the group should be looking at such an angle that they can see a little bit into the bowl, but cannot see the coin. One person in the group holds the coin in place with the eraser side of the pencil, while another person pours water (somewhat slowly) into the bowl. Observe.

#5 The Index of Refraction

Equipment : 1 tall cylindrical container, vase, or jug; 2 of the same coins.

Procedure : Fill the container so that the water is exactly 20 cm deep. Put one coin in the container and the other coin outside the container, such that they are close to one another, separated by only the container's wall. Look down at both coins so that you are looking through water at one coin and through air at the other coin. You can see best if *your forehead is positioned over the water*, and your eyes are *both* directly over the *edge* of the container.

The coin you are holding should *appear* to be higher than the one in the water.

Now bring the coin that you are holding toward the surface until the two coins *appear* to be at the same level. Measure, as accurately as possible, the *actual* distance from the surface of the water to the coin you are holding. All measurements should be to the nearest millimeter. Each person in the group should try this twice. Therefore a group of 3 people should have 6 measurements that are close, but slightly different, from each other.

#6 When Light Meets Dark

Equipment : 1 table water prism; prism cards #1 and #2; one card holder.

Procedure : Set the card holder about 4 feet away from the prism. Observe card #1 with the black side up, then card #1 with the white side up. For each card, pay attention only to lines (and color) appearing inside the card, *not* around the edges of the card. After everyone in the group has seen these two cases, have everyone observe card #2. Take notes and make a quick, but accurate, sketch of this card.

Considerations for Observation : You do not need to write about this, but be sure that you have enough written down (notes and a rough sketch) so that you can accurately draw card #2 (with the colors that you see) in your main lesson book.

#7 Two Spectrums

Equipment : 1 table water prism; a set of 5 prism cards; one card holder.

Procedure : Set the card holder about 4 feet away from the prism. Put card #1 in the holder with the white side down. Someone holds card #3 (all white) over card #1 and then slowly slides it down so that the effect is a narrowing strip of black. Move the card down very slowly just before the black strip vanishes. The observer should not tell others in the group what they see until everyone in the group has had a chance to observe. Repeat the same process with card #1 flipped over and sliding card #4 (all black) in front. Only after you are confident that you understand what happened above, you should observe card #5 (by itself).

Considerations for Observation : Be prepared to write about this in your book. Exactly what colors appeared, and under what circumstances? Accurately draw card #5, with all the colors, in your book.

#8 The Giant Water Prism

Equipment : 1 large triangular water prism (stood on a triangular side, and with an open top) filled partially with water. 2 yardsticks (or meter sticks).

Procedure : Part I : Look through the corner of the prism at objects in the room. Make observations.

Part II : Attach one yardstick vertically along the short side of the prism and one yardstick along the long side of the prism. Look through the corner of the prism at each yardstick and make observations.

Part III : Have a person hold a yardstick along the long side of the prism such that one hand is seen above the prism and the other is viewed through the corner of the prism. Observe what happens as the person slowly moves backward and away from the prism.

#9 Observations Through a Lens

Equipment : One ocular convex lens; one objective convex lens; a piece of paper with print on it.

Procedure : Start with the ocular lens, which is smaller and thicker. In the first case, one student holds the lens against the paper and then moves it slowly away from the paper while another student, who is standing about 4 feet away, is looking through the prism at the paper. Do this repeatedly and observe carefully.

NEVER LOOK AT THE SUN!!

In the second case, hold the lens yourself and look outside at something fairly distant. Start with your eye right up close to the lens and then slowly move it away.

Repeat these two cases with the objective (thicker) lens. For the first case, the observer should be standing about 12 feet away. In the second case, someone should hold the lens for the observer, who will have to move back quite a few feet.

Considerations for Observation : What is the same about how the two lenses behave? How are they different?

#10 Focusing an Image

Equipment : 1 optical bench set up, including ocular lens, candle with holder, and card with holder.

Procedure : Light the candle and place it at one end of the yardstick. Place the lens 10cm away from the center of the candle. Move the card back and forth until the candle is focused best. Write down the distance between the lens and the card. Repeat the same process, but starting with the lens at distances of 20cm, 40cm and 80cm from the candle.

Considerations for Observation : As the candle became further away from the lens, what happened to the focal distance? How did the image change?

#11 The Telescope

Equipment : 2 optical bench set ups; 3 ocular lens; 1 objective lens; 1 eye chart (with letters of a variety of sizes).

Procedure : On one optical bench (A) place two ocular lenses at a distance of about twice their focal distance. On the other optical bench (B) place an ocular lens and an objective lens at a distance equal to roughly the sum of their focal distances. Place the eye chart about 20m away. Now look through each of these telescopes – A and B.

Here is a tip on how to see through the telescope: Start by standing to the side of the telescope, two feet behind the ocular (eyepiece). Lean over to the side while looking through your lower eye. In the ocular lens you should see an image of the objective lens. Move forward (still leaning over with one eye closed) making sure that the image of the objective lens stays at the center of the ocular lens. Stop once the image of the objective fills the ocular. It takes some practice to be able to "see" properly. Keep trying! And, of course, you'll need to slide one of the lenses back and forth slightly in order to bring the object into focus.

You should be able to tell that looking through telescope A at the eye chart gives no more clarity than the naked eye. This is because there is no magnification. (It may seem that the image is smaller than normal. This is only because with normal sight our brains make a "correction" so that when an object moves away, we don't realize that the image at that back of our eye is getting smaller.) Telescope B does have magnification and allows to read more of the eye chart.

To Think About: Can you explain how the telescope works? (See the last page of the lesson plans, titled: "How a Telescope Works".)