

Lesson Topic: Transmission and Refraction of Light

Objective:

Students will be able to:

1. Recognize and explain the refraction of light as it moves through different media.

Time Required: 80 minutes

Materials Needed:

- Flashlight
- Index card with a hole, created with a hole punch, in the center (this will be taped to the flashlight to control the beam of light)
- Rectangular glass/Pyrex baking dish with water inside
- 4 Pennies
- 2 aluminum pie pans
- 10 beakers
- 2 saucers or plates that will cover beakers
- 2 pencils or rulers
- 2 pair of reading glasses (the stronger the better)
- 2 magazines or pages from a book
- Broken test tube (broken in half)- only the teacher will handle this item
- Intact test tube
- Corn oil
- Water
- Paper towels

Teacher Preparation:

- Assign a Legends of Learning Instructional [Quick Play](#) playlist for the day(s) you will be teaching the lesson.
 - Instructional - Middle School - Transmission and Refraction of Light
- Assign a Legends of Learning Content Review [Quick Play](#) playlist for the day(s) you will be teaching the lesson.
 - Content Review - Middle School - Transmission and Refraction of Light
- Prepare all exploration materials listed and be sure tables or desks pushed together are set up for students.
- Copy the Station Directions and Questions sheet for students (see attached).
- Place an intact test tube into the tall beaker of corn oil. Be sure the interior of the tube fills with oil. Do not tell students it's there.

Engage (10 minutes):

1. The teacher should turn off the lights, turn on the flashlight for students to observe. The teacher will then tape the card with the hole to the light, and shine it towards a white surface.
2. Ask the students what they notice about the light.
 - a. Students should notice that light moves in a straight line in both situations, but is more directed with the card covering the light's lens.

3. The teacher should then place the glass baking dish with water in front of the flashlight/card and ask students to notice any changes in the light. Be sure to angle the flashlight at the dish of water.
 - a. The light should not look the same as before. Instead of moving in a straight line, the light has angled and is moving in a different path.
4. Tell students they will explore other examples of this phenomenon and build understanding about the cause of this change.

Explore (20 minutes):

1. Students will rotate through stations and observe phenomenon. Teachers may want to set up two of each station to move more students through more quickly.
2. Students should make observations and propose explanations for each station and write their responses on the activity sheet.
3. Stations include:
 - Disappearing Penny
 - Reappearing Penny
 - Pencil/Ruler Oddity
 - Reading Glasses

Explain (30 minutes):

1. Define the term *media*.
 - a. Media - a transparent substance (air, water, clear liquid, etc.) through which light moves
2. Ask students to identify media they just explored.
 - a. Students should mention water, air, and glass
3. Define the term *refraction*.
 - a. Refraction - the bending of light rays as they pass at an angle from one medium into another medium
4. Ask students if they noticed any examples of how refraction might affect what we see?
 - a. Students should realize, based on their explorations, that as the light moved through new media, the way their eyes saw things changed because the direction of the light changed.
5. Have your students [sign in to Legends of Learning](#). Instruct students to complete the Instructional playlist.

Elaborate (5 minutes):

1. Tell students they will apply what they have learned to a magic trick.
2. Place the corn oil beaker on the table and explain to students that corn oil is in the beaker.
3. Show students the broken test tube (be careful of sharp edges) and tell them to observe what happens when it is placed in the corn oil. Drop it in the corn oil and be sure the oil fills the interior space of the tube pieces. It should make the tube “disappear”.
4. Say “abracadabra” and wave your hands above the beaker. Reach into the beaker and pull out the intact test tube and pour out the oil.
5. Students should propose explanations for what was observed.
 - a. Students should recognize that the test tube and corn oil are both media and

cause refraction of the light. This can play tricks on your eyes!

Evaluate (15 minutes):

1. Have your students [sign in to Legends of Learning](#). Instruct students to complete the Content Review playlist.
2. The exploration worksheet can be evaluated as well.

Additional Lesson Strategies:

- To use Legends for additional instruction, create a [custom playlist](#) with an [instructional game](#) and pre and post [assessment](#).
- To use Legends for a quick formative assessment, create a 5-question [assessment](#) in a [playlist](#).
- To use Legends for a student-directed experience, create a [targeted freeplay](#) playlist.
- Encourage students to play on their own at home in [Legends of Learning: Awakening](#) for a student-driven experience including avatars, battling, and quests all centered around topics they are covering in class.



Station Directions and Questions

Name: _____

Disappearing Penny:

Place the penny on the table. Place the base of the beaker over the penny and cover the top of the beaker with the plate/saucer. Look through the side of the beaker to see the penny. Tilt the plate/saucer back and fill the beaker with water. Replace the plate/saucer over the top of the beaker. Look through the side of the beaker for the penny.

Describe what you notice about the penny at this angle before and after adding the water to the beaker.

Remove the plate/saucer from the top of the beaker and look straight to the bottom from the top of the beaker. Look for the penny now.

How does the penny look from this position? _____

Relate what you saw to your understanding of how light travels.

Carefully pour the water from the beaker into the second beaker. Please leave the penny for the next group.

Reappearing Penny:

Place the penny in the center of the pie plate. Slowly lower your head until the coin *just* disappears from your view. Remain in this position as your partner slowly pours water from the beaker into the plate.

What do you notice as the water fills the tray? _____

Carefully pour the water from the plate back into the beaker and leave the penny for the next group.



Pencil/Ruler Oddity:

Observe the pencil/ruler in the beaker of water. Do not adjust the object in the water. Lower your head so that your eye is at the level of the water and observe the appearance of the object.

What do you notice about the object in the water? _____

Take the object and stand it upright in the beaker of water. Again, lower your head so that your eye is at the level of the water. Observe the appearance of the object. *Describe any differences in the appearance of the object as you moved from the tilted position in the beaker to the upright position.*

Since we have established that light travels in straight lines, how do you account for the changes in the positions of the ruler?

Please return the object to its original tilted position in the water for the next group to observe.

Reading Glasses:

Place the pair of reading glasses on the page of reading material on the table. You will not need to wear the glasses for this exploration. Lower your head so you can see the printed text through the glasses and the printed text on either side of the glasses.

Describe the difference between the printed text through the glasses and without the glasses.

Propose a reason for your observation.



Answer Key

Disappearing Penny:

Before adding the water, the penny is visible through the side of the glass. After adding the water, you can not see the penny through the side of the glass.

When you look directly down at the penny, it is clearly visible.

Light travels in a straight path. Looking straight down at the penny allowed us to see it.

Reappearing Penny:

Even though we were at an angle that prevented us from seeing the penny, the water made the penny visible again.

Pencil/Ruler Oddity:

The object appears broken or discontinuous when it's leaning against the edge of the glass.

When the object is held upright, it appears straight, without appearing broken or discontinuous.

When the object is lying against the side of the glass, or tilted against the glass, the light is bending more. When the object is straight there is less bending of the light.

Reading Glasses:

The print looks smaller through the lenses than it does around the lenses.

The lenses are a different medium than air, so the light must be bending.