Trick or Science: Catching the Light

Based on a lesson created by **Li-hsuan Yang**

By: Kimberly Higdon, Kathleen Yates, Kelly Cox, Corinne Conley, Laura French, and Jo Smith

Focus on Inquiry

The students will be able to observe, explain, and model reflection and refraction through a series of inquiry light stations.

Lesson Content Overview

Students will engage and perform different challenges to obtain knowledge about how light reflects off of surfaces and how light is refracted when changing mediums.

Duration	Setting	Grouping	PTI Inquiry Subskills
2 - 45 min class periods	classroom	Small groups/ stations	2.1, 3.7, 4.1, 5.2, 7.2

Lesson Components	Estimated Time	Inquiry Subskills Used	Technology Used	Level of Student Engagement	Brief Description
Engage	5 min	5.2	Video	2	Students watch a video with "tricks" involving reflection and refraction.
Explore	40 min	3.7	None	3	Students go to different stations and explore reflection and refraction.
Explain	15 min	4.1	None	3	Students explain each station and connect vocabulary to each activity.
Expand	15 min	2.1	None	3	Students design their own mirror trick using reflection and refraction.
Evaluate	15 min	7.2	None	2	Students will complete a summative assessment on reflection and refraction. Student will apply their knowledge to a short response scenario.

Level of Student Engagement

1	Low	Listen to lecture, observe the teacher, individual reading, teacher demonstration, teacher-centered instruction
2	Moderate	Raise questions, lecture with discussion, record data, make predictions, technology interaction with assistance
3	High	Hands-on activity or inquiry; critique others, draw conclusions, make connections, problem-solve, student-centered

Next Generation Science Standards – Inquiry

NGSS Practice 3: Planning and Carrying Out Explanations
NGSS Practice 6: Constructing explanations

Next Generation Science Standards – Physical Science

MS-PS4-2: Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials

Florida Science Standards – Nature of Science

SC.7.N.3.2: Identify the benefits and limitations of the use of scientific models.

Florida Science Standards – Physical Science

SC.7.P.10.2: Observe and explain that light can be reflected, refracted, and/ or absorbed.

Materials and Advance Preparation

Materials List

Class set:

1. Projector for video clips
2. Challenge #1: 3 mirrors
3. Challenge #2: 1 white cardstock with arrows drawn, 1 beaker, water
4. Challenge #3: 1 clear cup/beaker, 1 straw, water
5. Challenge #4: 1 bowl/beaker, 1 penny, meter stick, water

Student materials:

1. Blackline Master #1, 1 per group
2. Blackline master #2, 1 per student or group
3. Black line master #3, 1 per student
4. Blackline master #4, 1 per student

Blackline Masters

1. **Blackline Master #1** Trick Or Science: Challenge Activity Directions
2. **Blackline Master #2** Trick Or Science: Challenge Student Sheet
3. **Blackline Master #3** Reflecting on the Light Challenges
4. **Blackline Master #4** Light Behavior Check for Understanding

Advance Preparation

1. Make copies of all blackline masters, either per student or per group
2. Cut out message cards
3. Setup challenge stations
   - To see how to set up the mirror challenge (#1) see video: https://www.youtube.com/watch?v=lcx1qBoc04s
   - To see arrow challenge (#2) see video: https://www.youtube.com/watch?v=G303o8pJzls
4. Practice the challenges yourself
5. Make sure links are current and active

Lesson Information

Learning Objectives

1. The students will accurately be able to model reflection and refraction through a series of inquiry light challenges.
2. Students will engage and perform different challenges to obtain knowledge about how light reflects off surfaces and how light is refracted when changing mediums.
3. Students will identify the benefits and limitations of the use of scientific models.

Prior Knowledge Needed by the Students

Students should have a clear understanding of the different forms of energy, specifically that:

- light energy is a form of energy
- light energy has observable, and predictable properties
- light energy has observable, and predictable behaviors

Background Information

Reflection involves a change in direction of waves when they bounce off a barrier. The waves do not bend or change speed. **Refraction** of waves involves a change in the direction of waves as they pass from one medium to another. **Refraction**, or the bending of the path of the waves, is accompanied by a change in speed and wavelength of the waves. The **index of refraction** tells how much the wave will bend as it passes from one medium to the other. This lesson addresses reflection and refraction of light waves.

Lesson Procedure

Engage

1. Show students the following video clip or perform as a demo: http://www.tubechop.com/watch/8332743

NOTE: *If there is an advertisement at the beginning of the video, please fast forward or "Skip" through the ad if available. Make sure to display the video full screen (arrows to the right of video time bar at the bottom of the screen) so that the web page advertisements and other suggested videos are not seen. Watch for and close any pop-up ads that may occur during the video.*

Then ask the following questions:

1. Describe the demonstration that just occurred. Student answers may vary but could include when test tube went into the water you could still see it, but when it went into the oil, it was no longer visible.
2. What do you think caused the test tube to disappear? Student answers may vary but could include that light goes through the test tube and oil in the same way, but maybe it goes through the water a little differently.

2. Show students the following video clip or perform as a demo: https://youtu.be/ZWzZV9MBHVE

NOTE: *If there is an advertisement at the beginning of the video, please fast forward or "Skip" through the ad if available. Make sure to display the video full screen (arrows to the right of video time bar at the bottom of the screen) so that the web page advertisements and other suggested videos are not seen. Watch for and close any pop-up ads that may occur during the video.*

Then ask the following questions:

1. What did you observe in this video? Student answers may vary but could include; the two broken pieces of the tube disappeared and then after he stirred them, they came back together.
2. What are some possible explanations for what you saw in this video? Student answers may vary but could include that the two ends of the test tube "glued" back together, they were stuck together with oil, there was a whole test tube in the container that we couldn't see.

Explore

1. Students will now explore each challenge with their group.
2. Distribute **Blackline Master #1** to each group for the directions for each challenge.
3. Distribute **Blackline Master #2** for the Trick or Science Challenge Student Sheet.
4. Students will likely need approximately 5-10 minutes at each station.

Explain

1. After students have completed the challenges and recorded their observations, they will relate the experiences from each "trick" to the concepts of light reflection and refraction.
2. On the "Reflecting on the Light Challenges" activity, students will organize their observations from the challenges that they just experienced within the categories of "Reflection" and/or "Refraction." They will also provide justification for their choices.
3. When students are finished with their activity, groups will collaborate with another group to compare answers. The teacher will circulate through the classroom to help supplement the students' explanations and clear up misconceptions.
4. Teacher will then lead a discussion about the benefits, and limitations of the models used in these challenges. Some possible discussion starters could include:
    a. What are some benefits of using these models to observe these phenomena? *Possible student responses include: This was done in a controlled setting, with laboratory equipment approved for scientific experiments resulting in accurate results.*

b. What are some limitations of using these models to observe this phenomenon? *Possible student responses include: Some real-world applications of these concepts cannot be duplicated in laboratory conditions such as rainbows, sundogs, and moon halos.*

Expand

Ask the students to use what they have learned about reflection and refraction to create a trick of their own involving the materials that were used in the challenges. You may add additional materials that you have available (i.e. Food coloring, other clear liquids, multiple mirrors and targets, etc.) and may not just be limited to the materials used in the challenges performed.

Evaluate

FORMAL EVALUTION

- **Blackline master #3 – Light**

INFORMAL or OPTIONAL EVALUTIONS, WRAP UP.

- *Lab activity and reflection, as well as teacher observation, can serve as an informal assessment.*

Supplementary Resources

Teachers

An interactive website that could be shown on a smartboard as a whole group activity. Available from:

http://www.learner.org/teacherslab/science/light/color/index.html

"Piggy In The Mirror Podcast." The Loh Down on Science,5 Apr.2010.Web.01 Nov. 2016. *http://www.lohdownonscience.org/podcast/piggy-in-the-mirror/*

"Let There Be Light." Discovery. N.p., 21 Oct. 2015. Web. 01 Nov. 2016. http://www.discovery.com/tv-shows/mythbusters/videos/let-there-be-light/

Students

http://studyjams.scholastic.com/studyjams/jams/science/energy-light-sound/light-absorb-reflect-refract.htm

Perkins, Sid. "Vision-ary High Tech." *Science News for Students*. N.p., 20 Feb. 2015. Web. 01 Nov. 2016. https://www.sciencenewsforstudents.org/article/vision-ary-high-tech .

Article relating vision to humans.

CITATION OF SOURCES.

Based on the lesson "Engaging Activities to Explore Light and Vision" by Li-hsuan Yang; an in class resource from undergraduate study.

Ajizai. (2014). Refraction photo. Retrieved from https://commons.wikimedia.org/wiki/File:Refraction_photo.png

Allinone, C.L.S. (2014). Simple Experiment Infinity Mirrors: Video. Retrieved from https://www.youtube.com/watch?v=lcx1qBoc04s

Home Science. (2014). Amazing Water Trick - Amazing Science Tricks Using Liquid: Video. Retrieved from https://www.youtube.com/watch?v=G303o8pJzls

Yeany, B. (2015). Index of Refraction - disappearing glassware demonstration: Video. Retrieved from https://www.youtube.com/watch?v=9Tj2KMZhfoc

__✓__ Yes, I cited all materials and resources used in this lesson.

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Lesson authors' signatures

Blackline Master #1

Trick or Science: Challenge Activity Directions

Challenge #1

a. Divide into 2 groups.
b. Each group gets a mirror and stands at opposite ends of the table.
c. Arrange the mirrors on the table so that when you look into the other group's mirror you see the other group's members; not yourself (hint: move mirrors to see the reflection of your group).
d. Draw your final configuration on your challenge sheet.

Challenge #2

a. Place the card with the arrows drawn on it upright behind an empty glass beaker 18 centimeters away.
b. Have each group member draw what they observe.
c. Fill the beaker ½ way with water or until 1 arrow is underwater.
d. Have each group member draw what they observe.
e. Add water to the beaker until it is full.
f. Have each group member draw what they observe.

Challenge #4

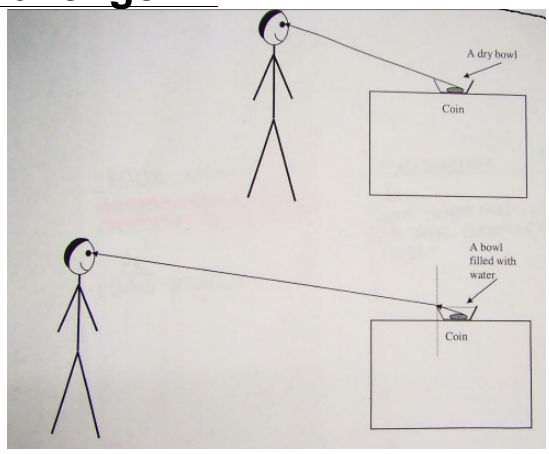


Figure 1

a. Place the penny in the bowl.
b. Have group member #1 walk backwards to where they can no longer see the coin in the bowl. Have group member #2 measure the distance from the group member to the bowl and ***record this distance as distance #1*** on your challenge sheet.
c. Have group member #3 pour water into the bowl until person #1 can see the penny again. Person #1 now walks backward again until they cannot see the penny anymore.
d. Have person #2 or #4 measure the new distance and ***record it on your challenge sheet as distance #2***. Use **figure 1** to help you if you need it.

Challenge #3

a. Using a beaker and a straw, place the straw into the beaker. Each group member draws what they are observing.
b. Have a group member fill the beaker half way with water while keeping the straw in the beaker. Each group member draws what they are observing.
c. Have a group member fill the beaker all the way with water while keeping the straw in the beaker. Each group member draws what they are observing.

Blackline Master #2

Trick or Science: Challenge Student Sheet

Challenge #1 **Draw your group configuration in this space:**		**Challenge #4** **Distance #1:** **Distance #2:**
Challenge #2 **Empty Beaker**	**Beaker half full**	**Beaker full**
Challenge #3 **Empty Beaker**	**Beaker half full**	**Beaker full**

Blackline Master #3

Reflecting on the Light Challenges:

Tell whether each challenge is an example of reflection, or refraction. Give evidence from the challenge to support your answers.

Reflection	Refraction
The process of light "bouncing" off of a surface. Light bounces off a surface at the same angle that the light goes in.	*The process of light "bending" as it passes from one medium to another. Light bends differently depending on what medium (liquid/gas) it travels through.*
Challenge #1	
Challenge #2	
Challenge #3	
Challenge #4	

Reflecting on the Light Challenges ANSWER KEY

Tell whether each challenge is an example of reflection, or refraction. Give evidence from the challenge to support your answers.

Reflection	Refraction
The process of light "bouncing" off of a surface. Light bounces off a surface at the same angle that the light goes in.	*The process of light "bending" as it passes from one medium to another. Light bends differently depending on what medium (liquid/gas) it travels through.*
Challenge #1 In this challenge, light reflects off the mirrors to allow students to see one another.	Refraction does not take place in this challenge.
Challenge #2 Light is reflecting off the card and the arrows to allow students to see the arrows.	Light is refracting from the air to water and back to air to cause the change in direction that students see in the arrows.
Challenge #3 Light is reflecting off the straw and the beaker to allow students to see them.	Light is refracting from the air to water to cause the change in direction (bend) of the straw.
Challenge #4 Light is reflecting off the bowl and the penny to allow students to see them.	Light is refracting from the air to water to cause the change in location (bend) of the penny.

Blackline Master #4

Light Behavior Check for Understanding

1. **Mario was learning about light behavior in science class, and the teacher showed the class a prism similar to the one in figure 1 below. Which behavior of light explains this observation?** *SC.7.P.10.2*

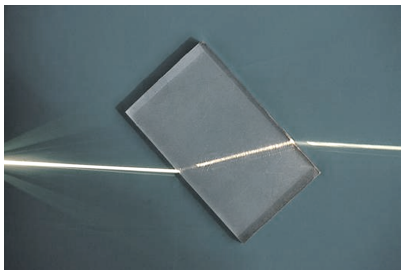


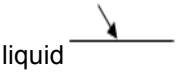
Figure 1

a. Reflection
b. Refraction
c. Diffusion
d. Interference

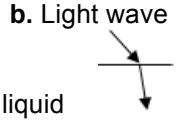
2. **When a wave hits a surface through which it cannot pass, it bounces back. This interaction with the surface is called:** *SC.7.P.10.2*
   a. Interference
   b. Diffraction
   c. Reflection
   d. Refraction

3. **A beam of light is shining on the surface of a liquid. Which diagram shows what happens when the light is reflected by the liquid?** *SC.7.P.10.2*

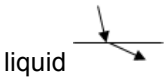
a. Light wave



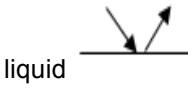
b. Light wave



c. Light wave



d. Light wave



4. **Rainbows are created when light passes through rain drops and separates into the different colors of light. Rainbows are a great example of light being:** *SC.7.P.10.2*
   a. Interfered
   b. Diffracted
   c. Reflected
   d. Refracted

5. **How is working with models of reflection and refraction, such as mirrors and prisms, beneficial to learning about the concepts?** *SC.7.N.3.2*
   a. Without the model, you cannot see reflection and refraction.
   b. Without the model, reflection and refraction would be too small to see.
   c. Without the model, you would not easily be able to experiment with reflection and refraction.
   d. Without the model, it would be much too dangerous to work with reflection and refraction.

Light Behavior Check for Understanding Answer Key

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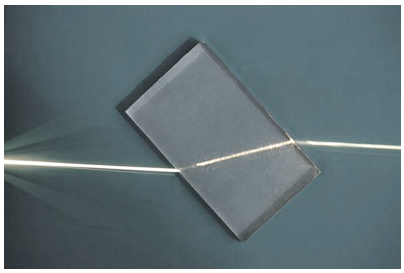

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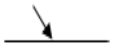
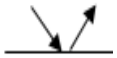


b. Light wave
liquid


c. Light wave
liquid


d. Light wave
liquid


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