Science Objectives

- Students will observe the path of light as it moves from one medium to another.
- Students will relate the angle of incidence to the angle of refraction.
- Student will determine the equation relating the angle of incidence, angle of refraction, and the refractive index of each medium that light is passing through.

Vocabulary

- angle of incidence
- angle of refraction
- refractive index
- Snell's Law

About the Lesson

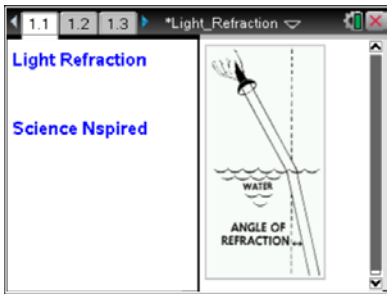
- This lesson visually explores refraction of light as it passes through different substances with different indexes of light.
- As a result, students will:
  - Understand the how light is bent when it passes through a different medium.
  - Be able to calculate the angle of refraction based on the ratio of the indexes of refraction

TI-Nspire™ Navigator™

- Send out the *Light_Refraction.tns* file.
- Monitor student progress using Screen Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- *Light_Refraction.tns* document
- TI-Nspire™ Technology



TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Use minimized sliders

Tech Tips:

Make sure that students understand how to change values of minimized sliders by clicking the arrows.

Lesson Materials:

Student Activity

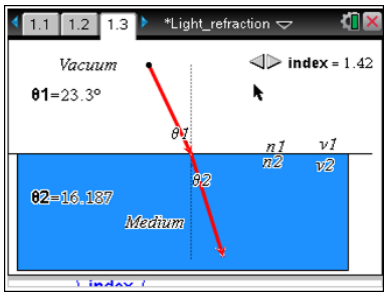
- Light_Refraction _Student.doc
- Light_Refraction _Student.pdf

TI-Nspire document

- Light_Refraction.tns

Discussion Points and Possible Answers

Move to pages 1.2–1.4.



1. Students should read information and instructions on pages 1.2 and 1.4. When students use page 1.3, they can change the index of refraction by clicking ◀ and ▶. This is a good time to talk about different substances having varying indexes. In this simulation, a vacuum is above the liquid, so the refractive index of the upper "medium" is 1. Students can grab the endpoint of the incident ray and move it to explore different angles of incidence.

Move to pages 1.5–1.8.

Have students answer the questions on either the handheld, on the activity sheet, or both.

Q1. When the refractive index of the liquid medium increases, _____.

Answer: B. $\theta_1 > \theta_2$

Q2. Calculate the sine of θ_1 and the sine of θ_2.

Answer: Answers will vary if students have changed the incidence angle and/or the refractive index.

Q3. What is the ratio of $\sin(\theta_1)/\sin(\theta_2)$?

Answer: Answers will vary.

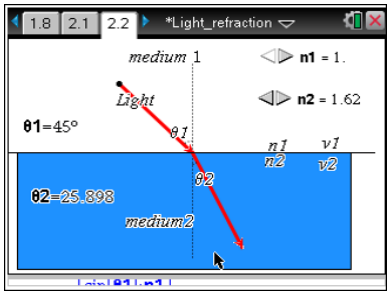
Q4. What is the relationship between the angle of incidence, the angle of refraction, and the medium's index of refraction?

Answer: The ratio of $\sin(\theta_1)/\sin(\theta_2)$ is equal to the medium's refractive index.

Tech Tip: Because θ_1, θ_2, and the refractive indexes are stored as variables, the students can actually put $\sin(\theta_1)$ and the sin of the angle will be calculated and they will not have to transpose the number.

Move to pages 2.1–2.3.

2. When students use page 2.2 they can change both indexes of refraction by clicking ◀ and ▶. This is a good time to introduce the concept of observing whether light is bent toward the normal or away from the normal. In this simulation, students can vary the index of refraction of each medium. The students can then grab the endpoint of the incident ray and move it to explore different angles of incidence.



Move to pages 2.4–2.10.

Have students answer the questions on either the handheld, on the activity sheet, or both.

Q5. If $n_1 > n_2$, then _____.

Answer: B. $\theta_1 < \theta_2$

Q6. Calculate the ratio of n_1/n_2.

Answer: Answers will vary.

Q7. Calculate the ratio of $\sin(\theta_1)/\sin(\theta_2)$.

Answer: Answers will vary.

Q8. How does the ratio of n_1/n_2 compare to $\sin(\theta_1)/\sin(\theta_2)$?

Answer: The two ratios are the reciprocals of each other.

Q9. The correct relationship between the angles and refractive indexes is/are _____.
(More than one response may be correct.)

Answer: B. $\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1}$ and C. $n_1 \sin\theta_1 = n_2 \sin\theta_2$

Q10. Air has a refractive index of 1.0003 and water has a refractive index of 1.3330. If a light ray in air strikes water at an angle of 50.0°, what will the angle of refraction be in water?

Answer: $\sin^{-1}\left(\frac{1.0003 \sin(15.0)}{1.3330}\right) = 11.2°$

Q11. A beam of light passes through a layer of benzene at a 20.0° angle to the normal. When it enters the layer of water, the angle of refraction is 30.88°. If the refractive index for water is 1.0003, what is the refractive index for benzene?

Answer: $1.0003\left(\frac{\sin(30.88)}{\sin(20)}\right) = 1.50$

TI-Nspire Navigator Opportunities

Use TI-Nspire Navigator to take screen captures of student progress and retrieve the file from each student at the end of the class period. The student questions can be electronically graded and added to the student portfolios.

Wrap Up

When students are finished with the activity, pull back the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions using Slide Show.

Assessment

- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved by TI-Nspire Navigator. The TI-Nspire Navigator Slide Show can be utilized to give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test, inquiry project, performance assessment, or an application/elaborate activity.