

# Make it invisible!

**Subject Area(s)** Physical science, Chemistry

**Associated Unit**

**Associated Lesson** The science of invisibility

**Activity Title** Make it invisible!



**Image 1**

**ADA Description:** This image shows a man with invisible body

**Caption:** None

**Image file:** Hollowman.jpg

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<http://www.wired.com/dangerroom/2008/08/army-eyes-invis/>

**Grade Level** 11 (9-12)

**Activity Dependency**

**Time Required:** 10 minutes

**Group Size:** 2 to 4 persons

**Expendable Cost per Group** US \$0.80

## Summary

Through this exciting activity which seems science fiction first, the students observe that a beaker is vanishing from their sights. So while this hands-on activity make them experiencing some kind of invisibility, it helps them to get a better understanding of the fundamental properties of light and light refraction in special that is essential to seek the reason of vanishing.

## Engineering Connection

An optical engineers researches and develops new technologies related to the science of light and design components of optical instruments such as lenses, microscopes, telescopes, , and other equipment that utilize the properties of light. Other devices include optical sensors and measurement systems, lasers, fiber optics communication systems or optical disk systems (e.g. CD, DVD), etc. Most professionals work in highly sophisticated laboratories, studying the behavior of light and seeing how it can be manipulated to enhance electronic systems and equipment. Optical engineers need to be intimately familiar with the properties of light and optics. Experts understand the mathematics and physics behind light wave movements, transfer, generation, and detection.

### **Engineering Category = #1**

Choose the category that best describes this activity's amount/depth of engineering content:

1. Relating science and/or math concept(s) to engineering
2. Engineering analysis or partial design
3. Engineering design process

### **Keywords**

Properties of light, refraction, refractive index, optics, invisibility

### **Educational Standards**

Texas, Science: (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;

### **Pre-Requisite Knowledge**

### **Learning Objectives**

After this activity, students should be able to:

- Investigate how light bends when it passes from one medium to another
- Explain refraction of light
- Define refractive index of materials
- Explain why the beaker appears invisible
- Explain what optical engineers do

### **Materials List**

Each group needs:

- Two clean Pyrex glass beaker, one small and one bigger
- Vegetable oil
- Wax pencil

- A beaker filled with water
- Straw

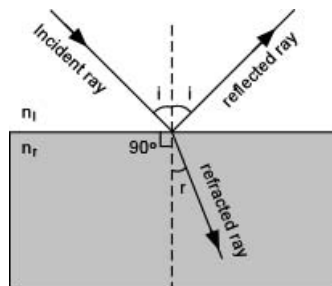
## Introduction / Motivation

The velocity of light in a material is lower than in a vacuum.

We here define *refractive index*,  $n$ , of a material or substance as the ratio of the speed of light in a vacuum,  $C$ , to the speed of light in a material through which it passes,  $C_m$ .

$$n = C/C_m$$

The speed of light in different materials is different. So light change direction when it passes from one medium to another at any angle other than  $90^\circ$  or  $0^\circ$ . This is called *refraction* of light. As the speed of light is reduced in the slower medium, the wavelength is shortened proportionately. The frequency is unchanged; it is a characteristic of the source of the light and unaffected by medium changes.



**Figure 2**

**ADA Description:** Refraction and reflection of light

**Caption:**

**Image file:** snellslaw.bmp

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The refraction of light when it passes from a fast medium to a slow medium bends the light ray toward the normal to the boundary between the two media. The amount of bending depends on the refractive indices of the two media and is described quantitatively by

$$n_i \sin (i) = n_r \sin (r)$$

## Vocabulary / Definitions

Word	Definition
Refraction	Change in direction of a wave due to a change in its speed
Refractive index	A measure of speed of light in a substance

## Procedure

### Background

This activity is considered to be done as part of the “Science of Invisibility” lesson plan but it can also be done independently to introduce the concept of light refraction. In the former case, it’s better to ask students to do this activity before introducing the invisibility technology by making individual atoms invisible (see “The science of invisibility” lesson plan).

### With the Students

Ask each group of students to take them to take the material listed above on their table and tell them that we are going to make small beaker disappear. Then ask each group to draw a happy face with a wax pencil on the side of baby beaker and place it inside the big beaker. Have them notice that they are able to see both beakers. Then ask them to start pouring vegetable oil into the smaller one and keep pouring even after overflow to the bigger one until the bigger beaker is filled with oil too. The little guy inside will disappear! So the kids see a 'floating' face inside the big beaker. So Cool!

So what’s going on here?

Ask the students to think and try to find out what caused beaker vanished. It may be hard for them to discover the reason. You can help them by asking them to put a straw in a beaker of water and notice that the straw looks like it is broken. Explain for them that light travels through thin air in a straight line but when it hits something transparent like water it bends. The amount of which something transparent bends light is related to its refractive index. It just so happened that the refractive indices of the Pyrex and vegetable oil are identical. So before filling with oil, the light beam passing through air and the Pyrex bends but when they move through Pyrex and oil, the just pass straight through. So the beaker looks disappeared.

In the science fiction book, H. G. WELLS, the invisible man turned his body invisible using the same principals. He changed his body refractive index to match of air. That seems a tale story but A group of scientists at London by using the same concept were able to make one individual atom invisible for a very short time.( see the ‘Science of invisibility’ lesson plan.

### Image 3

**ADA Description:** This image shows a man with invisible head

**Caption:**None

**Image file:** invisibility-face.jpg

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<http://educationcs.wordpress.com>



## **Attachments**

## **Safety Issues**

- No safety issue is required.

## **Troubleshooting Tips**

## **Investigating Questions**

## **Assessment**

## **Activity Extensions**

## **Additional Multimedia Support**

## **References**

<http://en.wikipedia.org/wiki>

## **Other**

## **Redirect URL**

## **Contributors**

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## **Supporting Program**

National Science Foundation GK-12 Program, University of Houston