Imagine you are sitting at a table with a red apple in front of you. Your friend closes the door and turns off all the lights. It is totally dark in the room. There are no windows in the room or cracks around the door. No light can enter the room.

Circle the statement you believe best describes how you would see the apple in the dark:

A. You will not see the red apple, regardless of how long you are in the room.
B. You will see the red apple after your eyes have had time to adjust to the darkness.
C. You will see the apple after your eyes have had time to adjust to the darkness, but you will not see the red color.
D. You will see only the shadow of the apple after your eyes have had time to adjust to the darkness.
E. You will see only a faint outline of the apple after your eyes have had time to adjust to the darkness.

Describe your thinking. Provide an explanation for your answer.
Una Manzana en la Oscuridad

Imagine que usted está sentado en una mesa con una manzana delante de usted. Su amigo cierra la puerta y apaga todas las luces. Está completamente oscuro en el cuarto. No hay ventanas en el cuarto o rendijas alrededor de la puerta. La luz no puede entrar en el cuarto.

Marque con un círculo la declaración que usted cree que mejor describe cómo usted podrá ver la manzana en la oscuridad:

A. Usted no verá la manzana roja, a pesar del tiempo que usted está en el cuarto.

B. Usted verá la manzana roja después de que sus ojos han tenido el tiempo de ajustarse a la oscuridad.

C. Usted verá la manzana después que sus ojos han tenido el tiempo de ajustarse a la oscuridad, pero no verá el color rojo.

D. Usted solamente verá la sombra de la manzana después que sus ojos han tenido el tiempo de ajustarse a la oscuridad.

E. Usted solamente verá el perfil borroso de la manzana después que sus ojos han tenido el tiempo de ajustarse a la oscuridad.

Describa lo que piensa. Proporcione una explicación a su respuesta.

______________________________________________________________________
______________________________________________________________________
______________________________________________________________________
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______________________________________________________________________
Apple in the Dark

Teacher Notes

Purpose
The purpose of this assessment probe is to elicit students’ ideas about how we see objects. The probe is designed to find out if students know that light must be reflected from an object and enter the eye in order to see an object.

Type of Probe
P-E-O

Related Concepts
Light, reflection, color, vision

Explanation
The best answer is A: You will not see the red apple, regardless of how long you are in the room. To see an object, some light must be present to reflect off the object so that it reaches the eye. The path of light is from the light source to the object to the eye. The probe states that this is a totally dark room. That means there is no light in the room. It is impossible to see an object in the absence of light (total darkness).

One reason some people think your eyes will eventually adjust to the darkness so you can see objects is because most people have never been in complete darkness. The eyes’ pupils enlarge in the dark to let as much light in as possible; but if there is no light, you cannot see objects regardless of how much your pupils dilate. Unless you have been in a cave, mine shaft, or sealed-off room, some ambient light is always present, even if it is very faint.

Curricular and Instructional Considerations

Elementary Students
In the early elementary grades, students learn that objects can be seen only when light is available to illuminate them. They observe and describe the difference in seeing objects in the dark and objects in the light, including shining a flashlight on objects. By the end of grade 5, their ideas about light expand to include the role of light in explaining how we see objects.
Students become familiar with terminology such as reflection, and draw models to show how an object can be seen when light reflects off the object and enters the eye.

**Middle School Students**
By the end of middle school, students expand their knowledge of how light travels to include reflection, refraction, and absorption. They trace the path of light as it interacts with different materials and objects including mirrors and lenses. They learn about frequency and wavelengths of light and can use these ideas to explain how we see white or color.

**High School Students**
Students develop more sophisticated ideas about light and optics in high school. They use both a wave and a particle model of light to explain features of electromagnetic radiation. They connect ideas about heat and temperature to electromagnetic radiation. Even though students at this level learn more advanced ideas about the electromagnetic spectrum and the behavior of visible light, they still may have strongly held preconceptions about seeing in the dark.

**Administering the Probe**
This probe is best used with students in grades 3–12. Make sure students understand that “totally dark” means no light at all can enter the room. Consider having students draw a picture to support their explanation.

**Related Disciplinary Core Ideas From the Framework (NRC 2012)**

**K–2 PS4.B: Electromagnetic Radiation**
- Objects can be seen if light is available to illuminate them or if they give off their own light.

**3–5 PS4.B: Electromagnetic Radiation**
- An object can be seen when light reflected from its surface enters the eyes.

**Related NGSS Performance Expectation (NGSS Lead States 2013)**

**Grade 4: Waves and Their Applications in Technologies for Information Transfer**
- 4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.

**Related Research**
- Most studies of commonly held ideas about light reflection were conducted prior to 2000, yet are still relevant today.
- Several studies have shown that students of all ages have difficulty understanding that light must enter the eye to see an object. Elementary and middle school students who do not understand that light is something that travels away from its source to another place have difficulty explaining reflection of light off objects (AAAS 2009).
- Piaget’s classic studies (1974) included young children’s ideas about light. He found that very young children often made no connection between an object and the eye.
- A variety of alternative conceptual models are used by students to explain how we see an object. These models include (1) rays that go from an object to the eye, (2) the fact that light just helps us see better without mention of how, (3) something goes from the eye to an object (eye as the activator of vision), (4) something goes back and forth between the eye and an object, (5) light goes from a source to the eye (and may include reflection) to help us see, (6) an image enters the eye, (7) a contrast with dark helps us see, and (8) sight goes further out when there is light (Driver et al. 1994).
- Ramadas and Driver (1989) reported that many of the children they surveyed did not recognize the necessity of light for vision and thought it was possible to see in total darkness. This may come from never
having been in a totally dark place. Furthermore, Featherstonhaugh and Treagust (1990) found that this misconception was more prevalent among city dwellers than rural dwellers. Among both city and rural dwellers, 40% believed that cats could see in the dark.

- The notion that the eye can see without anything linking it to an object is a persistent idea that exists even after students have had traditional instruction in optics (Guesne 1985).
- When drawing light rays to show how light travels to the eye, some students think the light ray is actually a material part of the light rather than a way to represent the light’s path (Galili and Hazan 2000).
- A very small number of children in several studies had an explanation consistent with the scientific view. Some evidence indicates that understanding increases with age and that the scientific view was more evident when students were asked to explain how they saw a lit flashlight in a mirror as opposed to how they saw a book on a table (Driver et al. 1994).
- The Harvard Smithsonian Center for Astrophysics Private Universe Project (1995) conducted interviews with children in the dark to find out if they believed they would see a red apple and a yellow and blue cube in a totally dark room and whether they would see the objects’ color. The students interviewed held persistently to the idea that if they waited long enough, their eyes would get large enough so that they would eventually see the objects.

Related NSTA Resources

NSTA Journal Articles

NSTA Press Books

Related NSTA Learning Center Resources

NSTA Science Object
Nature of Light: Characteristics of Light

NSTA Webinar
*NGSS Core Ideas: Waves and Their Applications in Technologies for Information Transfer*

Suggestions for Instruction and Assessment
- Be aware that most students have never experienced total darkness. There is usually some ambient light that allows them to see faint images. Ask if anyone has ever been in a cave with no lights and can describe what that was like.
• Have students test their predictions if you can provide a darkened room or dark box, or have them try this at home in a closet or windowless room with the light entering from under the door sealed off.
• Be aware that many children’s books describe animals as being able to see in the dark, implying that they can see in the absence of any light.
• Combine learning about the nature of light with how we see rather than treating them separately. Explicitly link how light travels from an emitting source and is reflected off an object, allowing us to see the object. Unless it is explicitly addressed in instruction, students may understand how light reflects in a certain direction in straight lines, bends, or is scattered but still fail to link these concepts with how we see.
• Have students develop and use a model to describe how we see objects in a room with light. For example, show students a picture of an apple on a table with a lit lamp next to the apple. Ask the students to draw a directional diagram with arrows and use it to explain how someone standing in the room can see the apple.
• A quick way for students to remember that light is needed to see an object is with the saying “no light, no sight.”
• Be aware that activities such as observing the widening of pupils of the eye in the dark and learning about nocturnal animals with large eyes may contribute to the idea that the eye alone is responsible for seeing. Emphasize that these biological features are intended to maximize the amount of light that can enter the eye.
• Consider modifying this assessment probe to ask students about other objects of a different color as well as white or black objects. Ask what they would see if there was some light coming in from under the door or through curtains in a window.
• Have students use the crosscutting concept of cause and effect in their explanation.

References