

The Physics of Vision

A Carolina Essentials™ Activity



Overview

Understanding vision requires a knowledge of physics, anatomy, and physiology. This activity emphasizes the physics of vision. By performing 2 simple activities that can be completed in less than 30 minutes, students investigate **parallax** and **depth perception**. Simple ray diagrams illustrate the interaction of light rays (physics) with the anatomy of the eye.

Life Science, Physical Science and Physics

Grades: 8–12

Essential Question

How can physics be used to explain vision?

Activity Objective

1. Explain the term *parallax* using appropriate physics concepts.
2. Explain the term *depth perception* using appropriate physics concepts.

Next Generation Science Standards* (NGSS)

PE HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models <ul style="list-style-type: none">• Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.	LS1.A: Structure and Function <ul style="list-style-type: none">• Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.	Structure and Function <ul style="list-style-type: none">• The way an object is shaped or structured determines many of its properties and functions.

Safety Procedures and Precautions

Use unsharpened pencils only. If using glass test tubes, make sure there are no chips or cracks on the rim of the tubes.

Teacher Preparation

Print, draw, or cut out bars about 1 inch high by 3 inches wide for 2 to 3 groups to share. Hang them on different walls, at student eye level. Students should stand 2 to 3 feet from the image.

Teacher Disposal

Collect pencils and test tubes from students.

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TIME REQUIREMENTS



PREP | **ACTIVITY**
10 min | 20 min

Teacher Prep: 10 min

Student Activity: 20 min

SAFETY REQUIREMENTS



MATERIALS (PER PAIR OF STUDENTS)

1 drawn, printed, or cut paper strip taped to the wall at eye level

1 unsharpened pencil

1 plastic or glass test tube

HELPFUL LINKS

[Optics of the Human Eye](#)

[Make the Invisible Visible: Detecting IR Light with a Smartphone](#)

REFERENCE KITS

[Carolina Visual Perception Kit](#)



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Student Procedure

Activity 1: Parallax

1. Look at the bar on the wall. Stand 2 to 3 feet in front of the image.
2. Close your right eye and extend your right hand with your thumb up.
3. Position your thumb so that it covers the center part of the bar.
4. Without moving your thumb, open your right eye and close your left eye.
5. Record your observations.
6. Repeat the process but begin with your left eye closed.
7. Still using your right thumb, place it in the center of the bar.
8. Open your left eye and close the right eye.
9. Record your observations.

Activity 2: Depth Perception

1. Work in pairs. One person needs a pencil and the other needs a test tube.
2. Stand opposite each other at arm's length.
3. The person with the pencil needs to close an eye and place the pencil in the test tube without touching the sides of the tube.
4. Switch positions.
5. Make observations.

Data and Observations

Activity 1

Students should report that the bar appears to move. When the right eye is closed first, the bar appears to move to the right. When the left eye is closed first, the bar appears to move to the left.

Activity 2

It will take multiple attempts for students to get the pencil in the test tube. Depth perception has been altered.

Analysis and Discussion

1. Explain how Activity 1 illustrates the concept of parallax. *Parallax is defined as the apparent change in the position of a distant object due to the change in position of the observer. When a subject has one eye closed, the position at which light enters the open eye and is perceived by the brain is different than the position of the closed eye once it is reopened.*
2. Explain why it was difficult to place the pencil in the test tube. *Each eye perceives a different image, but there is a large area where the field of view of each eye overlaps and the visual cortex processes this as a single image. This process also allows the brain to estimate distance, which is known as depth perception. Although the brain uses other clues to perceive depth, when one eye is lost or simply closed, depth perception can be affected.*

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Teacher Preparation and Tips

Using a bar helps students quantify the apparent shift in thumb position.

Hang the bars as close to student eye level as possible.

Remind students that parallax can be a source of error in measurements. It is a good scientific practice to read instruments directly at eye level to avoid parallax errors.

Watch students carefully to make sure students do not break test tubes if using glass.

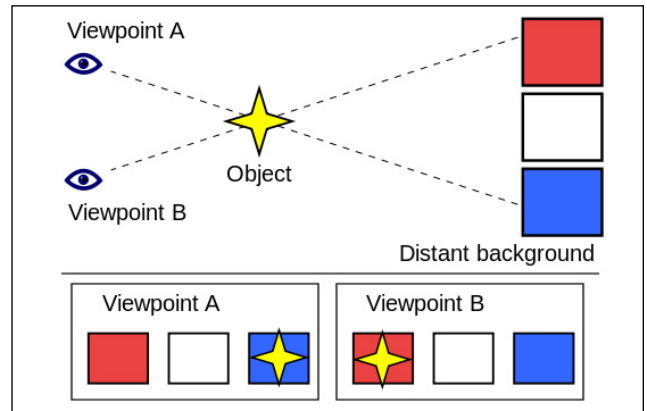
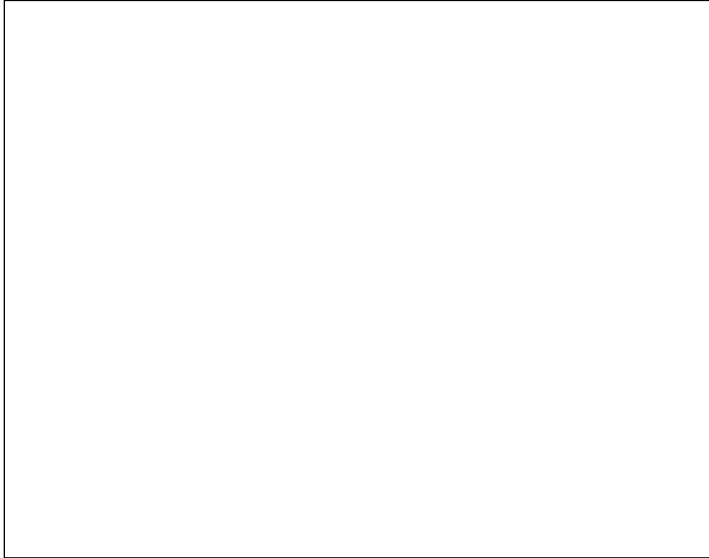
Physics students should complete detailed ray diagrams. Anatomy and physiology students should sketch the path of light from the object to the eyes.

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3. Complete a ray diagram or sketch for both activities.

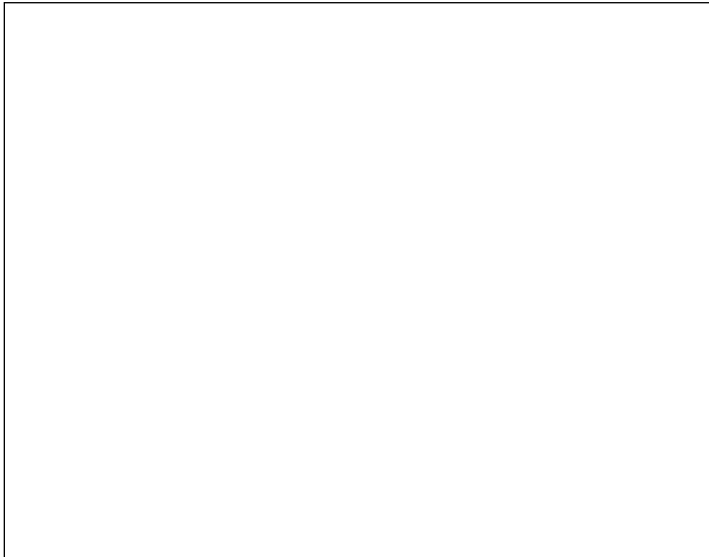
Activity 1



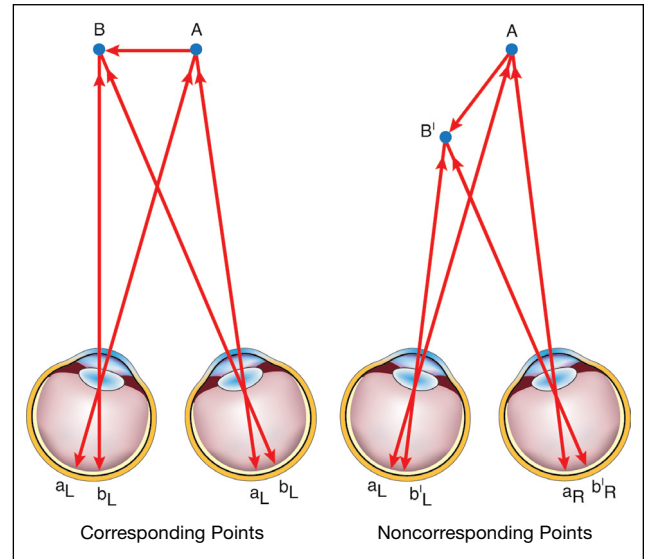
An illustration of parallax of an object against background due to a perspective shift. When viewed from Viewpoint A, the object appears to be in front of the blue square.

When the viewpoint is changed to Viewpoint B, the object appears to have moved in front of the red square.

Activity 2



Depth Perception



4. Humans and other predators have binocular stereoscopic vision because their eyes are on the fronts of their heads. Rabbits and many other prey animals have panoramic fields of view because their eyes are on the sides of their heads. What advantages does each type of vision provide? *Predators must judge distance and speed to catch prey so binocular stereoscopic vision is beneficial. Prey need a wider angle of vision to detect predators.*

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TEACHER NOTES