



Name: _____

Date: _____

Student Exploration: Eyes and Vision 2 – Focusing Light

[Note to teachers and students: This Gizmo was designed as a follow-up to the Eyes and Vision 1 – Seeing Color Gizmo. We recommend doing that activity before trying this one.]

Vocabulary: cornea, diameter, focus, iris, lens, optic nerve, pupil, retina

Prior Knowledge Questions (Do these BEFORE using the Gizmo.)
Javier is looking through a magnifying glass at a toy car that is sitting on a table a few feet away. The car appears to be upside down.



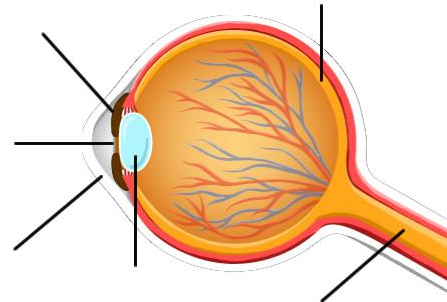
1. How do you think a magnifying glass makes objects appear upside down? _____

2. How do you think an eye is similar to a magnifying glass? _____

Gizmo Warm-up


Once light enters the eye, how is the light **focused** to make an image? You will answer this question in the *Eyes and Vision 2 – Focusing Light* lesson.

To begin, learn the names of the different parts of the eye. On the *Eyes and Vision* Gizmo, select the **FOCUS** tab. Turn on **Show labels**.

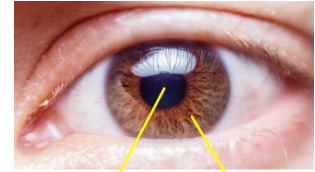


1. Fill in the above diagram with the parts of the eye.
2. Guess which parts of the eye have these functions. (Don't worry if you are wrong.)
 - A. Which part is an opening that allows light inside? _____
 - B. Which part bends the light that enters the eye? _____
 - C. Which part detects the light that goes into the eye? _____



Activity A: The pupil	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> • On the FOCUS tab, turn off Show labels. • Check that the Distance is 1.00 m and the Light intensity is 50%. Set the Lens roundness to 20%. 	
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Introduction: Light first enters the eye through a clear, protective window called the **cornea**. Next, light passes through an opening called the **pupil**. The size of the pupil is controlled by a colorful structure called the **iris**.



Pupil Iris

Question: How does the eye control how much light gets inside?

1. Predict: The distance across the pupil is its **diameter**. The diameter of the pupil changes in response to the brightness of the light.

In bright light, do you think the pupil diameter will get larger or smaller? _____

In dim light, do you think the pupil diameter will get larger or smaller? _____

2. Observe: Turn on **Show what the eye “sees.”** Move the **Pupil diameter** slider back and forth. What do you notice about the apple? _____

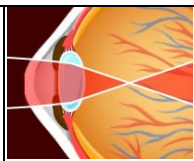
3. Collect data: Change the **Light intensity** to the settings in the table below. Then, adjust the **Pupil diameter** until the brightness of the apple looks “normal,” like the image at right. Record the ideal pupil diameters below.



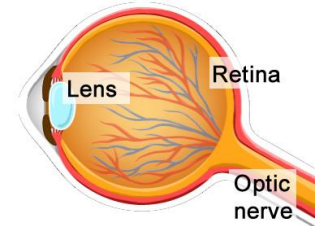
Light intensity %	Pupil diameter (mm)	Light intensity %	Pupil diameter (mm)
25%		75%	
50%		100%	

4. Analyze: What does the data tell you about how pupil diameter responds to bright light?

5. Apply: You walk outside into direct sunlight and your eyes hurt because it seems so bright. After a few seconds you see normally again. What is happening to your pupils? Explain.

Activity B: The lens	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> • Set the Distance to 1.00 m, Light intensity to 50%, and Pupil diameter to 4.0 mm. • Turn off Show what the eye “sees.” 	
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Introduction: Light passes through the pupil into the **lens**, a round structure that bends light. The light then forms an image on the **retina** at the back of the eye. The **retina** is a sheet of cells that detects light and sends signals through the **optic nerve** to the brain.



Question: How does the lens focus light that enters the eye?

1. Observe: Set the **Lens roundness** to 100%. Look closely at the light that goes into the eye.

A. What happens to the light when it passes through the lens? _____

B. Look at the image of the apple on the retina. What do you notice about this image?

2. Observe: Next to **Show**, select **Ray trace**. This shows what happens to a single ray of light reflected from the top of the apple and a single ray reflected from the bottom of the apple.

A. Where does light from the top of the apple end up? _____

B. Where does light from the bottom of the apple end up? _____

C. Why is the image of the apple on the retina upside down? _____

3. Explore: If you have ever used binoculars or a telescope, you may have noticed that what you see sometimes looks blurry. To see a sharp image, you may need to adjust the distance between the lenses. Unlike the glass lenses in binoculars, the lens in the eye is “squishy.” Small muscles change the *shape* of the lens to bring the image into focus.

Check that the **Distance** is 1.00 m. Set the **Lens roundness** to 20%. Turn on **Show what the eye “sees.”**

A. Is the apple blurry or in focus? _____

B. Reduce the **Lens roundness** to 0%. What happens? _____

C. Increase the **Lens roundness** to 50%. What happens? _____

(Activity B continued on next page)



Activity B (continued from previous page)

4. Predict: A lens bends light because it has a rounded shape. The rounder the lens, the more it bends light. Predict how the lens shape will change if the distance to the object changes.

If an object moves farther away, will the lens become flatter or rounder? _____

If an object moves closer, will the lens become flatter or rounder? _____

5. Collect data: With the **Distance** slider, change how far the apple is from the eye. For each distance, find the lens roundness that produces the sharpest image. Record your results.

Distance (m)	Lens roundness (%)	Distance (m)	Lens roundness (%)
0.20 m		0.80 m	
0.40 m		1.60 m	

6. Analyze: As an object gets farther away, how does the shape of the lens change to keep it in focus? _____

7. Explore: Turn off **Show what the eye “sees.”** Next to **Show**, select **Focus**. Set the **Distance** to 0.50 m and the **Lens roundness** to 12%. This view shows two rays of light reflecting from the same place on the apple and both going through the lens.

A. Do the two lines from the apple meet at the same spot on the retina? _____

B. Do you think the apple will be in focus? _____

Check by selecting **Show what the eye “sees.”**

C. Adjust the **Lens roundness** until the two focus lines meet at the same spot on the retina. Is the apple in focus now? _____

In general, the image will be in focus when all the rays of light from one point on the object meet at one point on the retina.

8. Summarize: Explain how the lens changes shape to help us see near and distant objects.

