A Lens to Demonstrate Accommodation in the Focusing of the Human Eye

Low-Cost Version

Dyan McBride*, Dean Zollman & Sytil Murphy

Kansas State University

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* Present address: Mercyhurst College, Erie, PA 16546

Purpose

The human eye changes shape (accommodates) in order to focus on objects which are located at different distances from it. To mimic this change of shape and help students understand the optics of accommodation, *we have developed a low-cost, robust lens which has a variable focal length.*

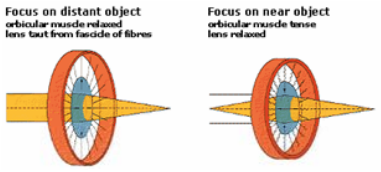
The Apparatus

An overview of the apparatus

The image is out of focus

The thickness of the lens is adjusted; the image is in focus

Accommodation



Adapted from
www.augen.de/uploads/RTEmagicC_4c78fee701.gif

The Accommodating Lens

Creating an analogy of the ciliary muscles would be extremely difficult. However, creating a similar process that shows how accommodation can occur is relatively easy. Our version is constructed of PVC and a transparent film, as shown below. Once constructed the lens is filled with water using a syringe. The focal length of the lens is adjusted by changing the amount of water in the lens.

Model of the Eye

The model of the eye is a simple arrangement of the variable lens to represent the lens of the eye and a screen to represent the retina. Students place a screen at a fixed distance from the lens, usually about 30 centimeters. This distance represents the distance between the eye lens and the retina. Thus, it cannot be changed during the rest of the experiment. A light source placed in front of the lens will then create an image on the screen.

Simulating Accommodation

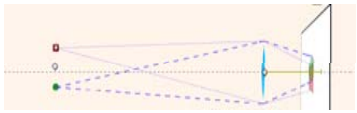
A light source is placed at different distances from the accommodating lens. At each distance, the students use the syringe to adjust the amount of water in the lens until the image is focused on the screen. Data are taken on the location and the thickness of the lens. We also ask students to record qualitative information about the curvature of the lens for each location of the object. Our students have found that they can bring the object into focus from a few centimeters in front of the lens to about four meters.

Accommodation and Vision Defects

Accommodation also plays a role in vision defects and can help us partially adjust to abnormal vision. To enable students to discover how this attribute improves our vision, we have them set up a situation where the object is in focus on the "retina." Then they move the retina slightly toward the eye lens (farsighted eye). The students can then change the amount of water in the lens to bring the object back into focus. By moving the "retina" even closer, they can repeat the experiment. However, they will reach a location for the retina where the accommodating lens can no longer focus the object. Thus, the defect is severe enough for the eye to need a corrective lens. A similar experiment can be completed with the retina moving away from the eye lens (nearsighted eye).

Sample Explanations

Using sketches and ray diagrams, the students describe how the changes in the lens shape changes the focal length of the lens.



The lens is too thin to focus the object on the screen. Thus, the focal length is too long. This situation represents an eye lens that has not accommodated properly. The vision is blurred.

The location of the object and screen are the same as in the diagram to the left. Now, the lens is thicker. It also has a shorter focal length. The vision of this "person " is clear.