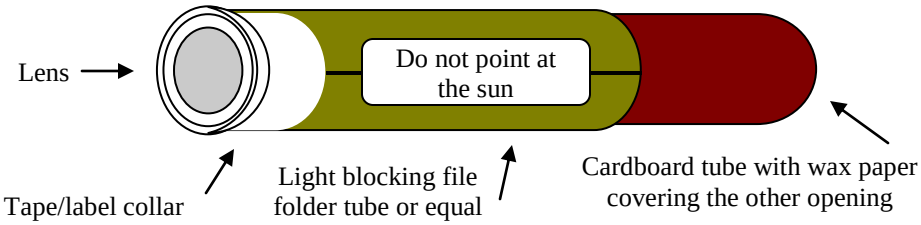
Modeling Near and Farsightedness

Experience common visual defects and their correction



Use an image viewer to create out of focus nearsighted or farsighted images. These blurry images can be "corrected" with a concave or a convex lens.

Topics: Light, Optics, Refraction

Materials List

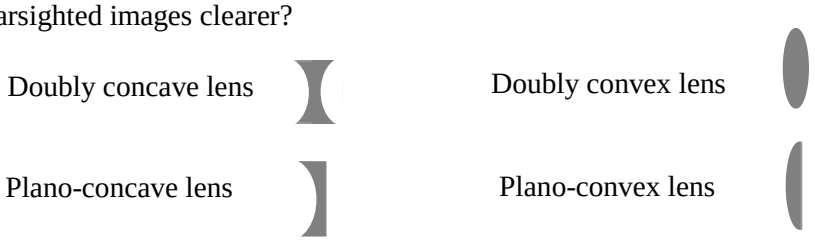
- ✓ Image viewer – see RAFT Idea Sheet ***Image Viewer***
- ✓ Convex lens (doubly or plano)
- ✓ Concave lens (doubly or plano)
- ✓ Large print sample, with 1 - 1.5 cm (⅜" - ½") high letters
- ✓ Opaque paper
- ✓ Single hole punch
- ✓ Eyeglasses that can correct near or far-sightedness

This activity can be used to teach:
Next Generation Science Standards:

- Light reflecting from objects and entering the eye allows objects to be seen (Grade 4, Physical Science 4-2)
- Waves are reflected, absorbed, or transmitted ((Middle School, Physical Science 4-2)
- Science & Engineering Practices (Grades 3-12)

To Do and Notice

1. Point the image viewer at a "near" view, about a foot away. Look in the open end and slide the tubes in and out until the image is in focus. Now look at a far view, 10+ feet away. To create a focused image which way do the tubes need to be slid, in or out? Keep the tubes in this new position for activities 2 to 4.
2. Look at a "near" view again. How does the image look?
3. The image viewer is modeling **farsightedness** when the "far" views are in focus but the "near" views are out of focus.
4. With the viewer adjusted to model farsightedness look at some large printed words, 1 - 1.5 cm (⅜" - ½") high that are about 30 cm (1 ft) away from the lens. Place a concave lens in between the image viewer and the printed letters. Move the lens back and forth. Repeat with a convex lens. Which lens can "correct" the farsightedness by bring the letters into focus?
5. Move the viewer to look at a brightly lit "near" view and slide the tubes in and out until the image is in focus. Keep the tubes in this new position and look at a "far" view, 3 - 10 meters (10-30 ft) away. Is the "far" view in focus?
6. The image viewer is modeling **nearsightedness** when the "near" views are in focus but the "far" views are out of focus. Keep the tubes in this new position.
7. With the viewer adjusted to model nearsightedness look at a "far" view. Place a convex lens in between the image viewer and the "far" view. Move the lens back and forth. It may work best to have one person look through the viewer while a second person holds the "corrective" lens over the image viewer's lens. This second person then moves the lens to focus the distant view. The "corrective" lens must be parallel to the image viewer's lens. Repeat with a concave lens. Which lens can "correct" the nearsightedness by bring a part of the "far" view into focus?
8. Punch a small hole in an 8 cm (3") square of opaque paper. Repeat activities 4 and 7 using the hole in the paper in place of a lens. Is a clearer imaged formed? In order to see any differences bright lighting will be needed for near viewing.
9. Repeat activities 4 and 7 but use a pair of eyeglasses from a near or farsighted person in place of the concave or convex lenses. Do they make the blurry near or farsighted images clearer?



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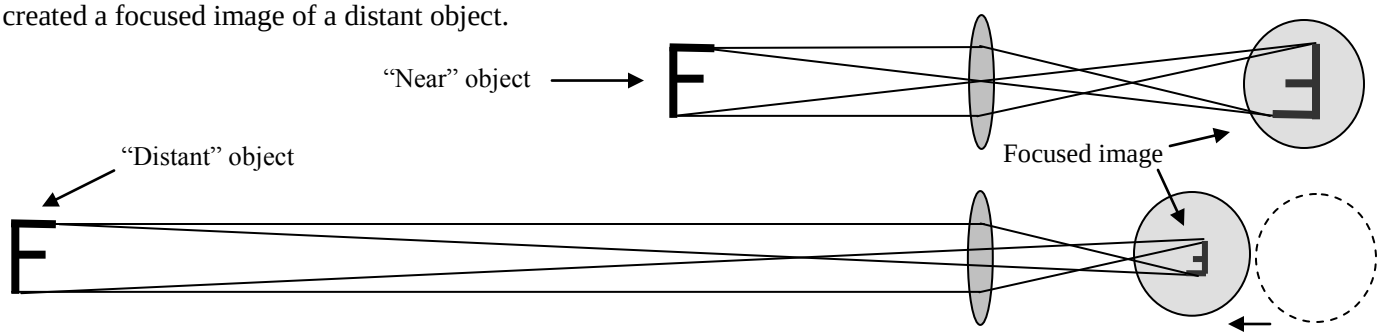
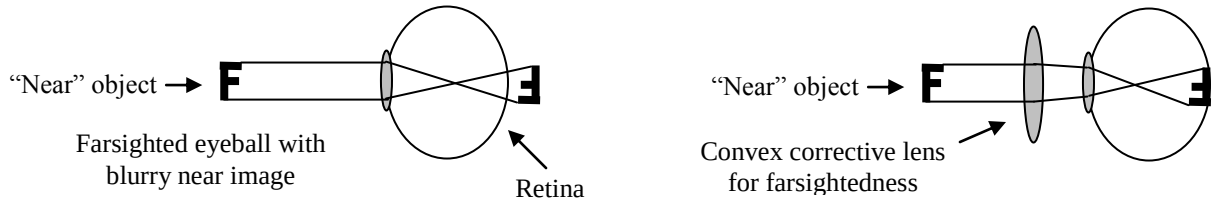
Designed and written by Michael Pollock (RAFT)

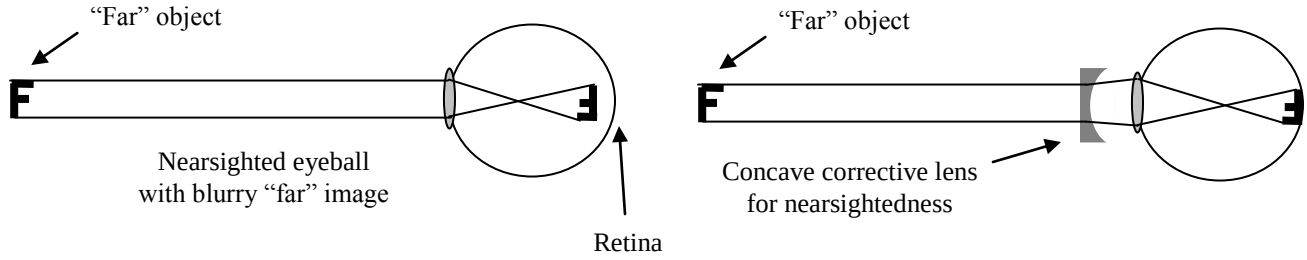
The Science Behind the Activity (Simplified light ray diagrams and eyeballs are not to scale)
The light rays reflected or originating from a "near" object are focused farther from the surface of a lens than light rays coming from a distant object. The tubes, when focused on a near object, have to be slid together to created a focused image of a distant object.



In a properly shaped eyeball the light rays focused by the cornea and lens will create a clear image on the retina. In an eyeball that is shorter than normal only the far views form a clear image and the person is farsighted. Near views would be focused "behind" the retina unless moved forward by placing a corrective converging (convex) lens in between the object and the eye.



In an elongated eyeball only the near views are in focus and the person is nearsighted. The far views are focused in "front" of the retina unless moved back by placing a diverging (concave) lens between the object and the eye.



A hole in an opaque paper can help create a more focused image by blocking light rays that could cause the image to be blurry, see RAFT Idea Sheet ***Image Viewer*** for details.

Note: Convex lenses converge and concentrate light rays. **Pointing a lens toward the sun could cause eye damage**. The sun's rays could also be accidentally focused into a hot spot that could cause a fire.

Taking it Further

Explain why a person who is farsighted will hold things at arm's length when not wearing contacts or eyeglasses. Explain why a person who is nearsighted can make distance images become more focused by looking through a small opening ("pinhole") when not wearing contacts or eyeglasses (see the RAFT Idea Sheet ***Image Viewer***).

Web Resources (Visit www.raft.net/raft-idea?isid=230 for more resources!)

- Ray Diagrams for Lenses http://hyperphysics.phy-astr.gsu.edu/hbase/geoopt/raydiag.html
- Anatomy of a Lens - http://www.physicsclassroom.com/class/refrn/Lesson-5/The-Anatomy-of-a-Lens
- Simulated optical experiments and ray diagrams based on applets - http://www.phys.hawaii.edu/~teb/optics/java/clens