RAFT IDEAS

Topics: Light, Optics, Refraction

Materials List

- ✓ Cardboard binoculars (or other source of convex and concave lenses) [Please note glass lenses can break and plastic lenses can be easily scratched]
- ✓ Tape or labels
- ✓ Straws, drinking ("jumbo" size)
- ✓ White paper or card, preferably a ruled index card
- ✓ Ruler
- ✓ Printed material
- ✓ Scissors

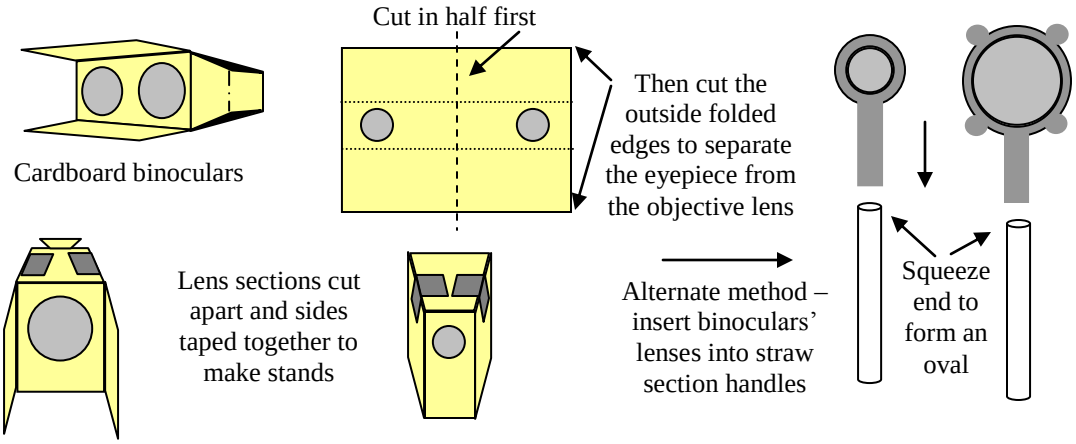
This activity can be used to teach:

- Light reflecting from objects and entering the eye allows (Next Generation Science Standards: Grade 4, Physical Science 4-2)
- Waves are reflected, absorbed/ transmitted (Next Generation Science Standards: Middle School, Physical Science 4-2)
- Science Practices (Next Generation Science Standards: Grades 4-8)

raft resource area for teaching
www.raft.net

Lens Explorations

Optical activities done with lenses from cardboard binoculars



Explore convex  and concave  lenses with these easy to "handle" and use plastic lenses.

Assembly

1. Cut cardboard binoculars in half by cutting between the two eyepiece lenses.
2. Cut the lens sections apart by carefully cutting the outside folded edges of the cardboard and separating the objective and eyepiece lens sections.
3. Fold and tape the cardboard flaps together, as shown, to make a stand.

Optional mounting technique to create "Lens Lollipops"

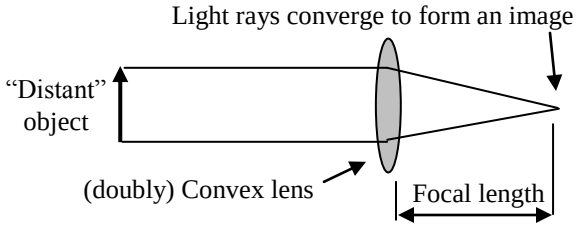
1. Remove the plastic lenses from the cardboard; avoid any sharp edges!
2. Remove any sharp points and smooth the sides of the plastic strip, which joined the lenses, by trimming any jagged edges.
3. Cut a straw into 6 cm (~2½") long sections. Squeeze an end of the straw to form an oval and insert the lens' plastic strip. Add glue for a more secure fit.

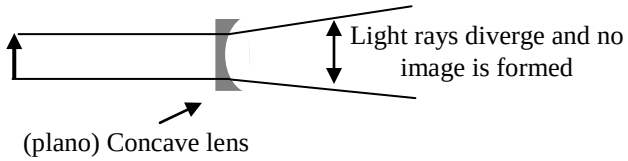
To Do and Notice (Caution – **Do not look at the sun through the lenses!**)

1. Binoculars have large convex objective lenses, thicker in the middle than at the edges. The lenses could be doubly convex (curved out on both sides ) or plano-convex (flat on one side).
2. Hold the convex lens above and parallel to a white paper or card placed on a flat surface with overhead lighting. Move the lens nearer or farther away until the clearest image of the overhead lighting is seen. Measure the distance between the lens and the white surface. This distance is a rough measurement of the focal length of the lens.
3. The smaller lenses in the binocular are the eyepiece lenses. Closely examine the surface of the lens visually or with a gentle touch. The lens is concave, thinner in the middle than at the edges. The lens could be doubly concave (curved in on both sides ) or plano-concave (flat on one side ).
4. Repeat activity 2 with the concave lens. Is an imaged formed?
5. Use each lens to examine printed material and/or a lined index card. Which lens makes the printed material look bigger? Which lens makes the printed material look smaller? Does flipping a lens over make a difference?
6. Look at a distant view. Which lens creates an inverted image? Look at near and far views through different pairs of lenses. Which combinations create an enlarged image? Which combination creates an enlarged upright image?

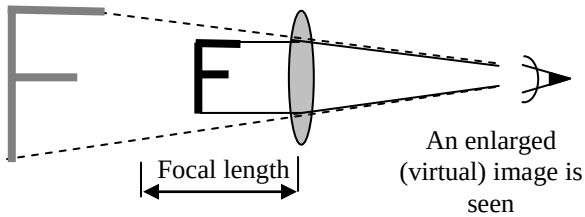
Developed and written by Michael Pollock (RAFT)

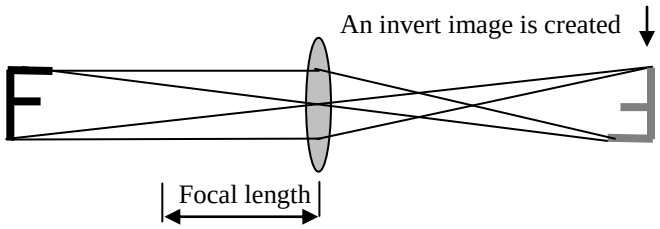
The Science Behind the Activity (Simplified light ray diagrams are not to scale)
Light that is reflected or emitted from an object can change direction when crossing into a different material. Light ray diagrams show the rays bending in the lens ("thin lens approximation") although most light rays bend when entering the lens (air to glass/plastic) and again when leaving (glass/plastic to air). Light rays from a distance object are essentially parallel, and for a convex lens, will focus an image at the focal length of the lens. The distance between the lens and the image of the overhead room lighting is a rough measure of the lens' focal length. A better approximation can be made when the light source or object is at least 6 meters (~20ft) away. A concave lens makes the light rays diverge so no image is formed.





The image seen through a convex lens will appear upright and enlarged when the object being viewed is within the focal length of the lens. The image will be inverted when the object is farther away than the lens' focal length.





Flipping a lens over will make no difference in the effective path of the light rays, even for plano-concave and plano-convex lenses.

When two lenses are used in combination they need to be held in line and parallel to each other to prevent distortions. See the RAFT idea sheet ***Telescope it out!*** for information on telescope design and the science involved.

Note: Convex lenses converge and concentrate light rays. **Pointing a lens or telescope 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
Repeat the **To Do and Notice** activities with other lenses that have different focal lengths.

Web Resources (Visit www.raft.net/raft-idea?isid=532 for more resources!)
- Image formation by lenses - http://www.physicsclassroom.com/Class/refrn/U14L5a.html
- Lens and telescope basics - http://www.lhup.edu/~dsimanek/scenario/lenses.htm