Drexel-SDP GK-12 ACTIVITY

Telescopes and Lenses

Science

Astronomy - Optics

Telescopes and Lenses

Grade Level _6_ (_6_-_6_)

Time Required: 2-4 Class Periods

Group Size: Groups of 2-3

Expendable Cost per Group: $12

Lesson Dependency: Marshmallow Worksheet

Summary

The telescopes and lessons activity coincides with a unit on astronomy. Students will learn about lenses, telescopes, and light as information. Students will make observations about lenses and mirrors, create lenses and mirrors of their own, and then use different lenses to create a telescope. Ultimately the students will use what they have learned to explain the functionality of their classroom overhead projector.

Engineering Connection

This activity connects to astronomy by showing real-world connections to light waves as information, the concept that light, as information, must travel at the speed of light and therefore, there is some lag between emitted light and perceived information. The construction of lenses to bend light has connections to eyeglasses, satellite dishes, telescopes, and "seeing the past."

Keywords

Optics, astronomy, lenses, concave, convex, mirror, telescope, light

Educational Standards

- 3.1.7A Explain the parts of a simple system and their relationship to each other.
- 3.1.7B Describe the use of models as an application of scientific or technological concepts.

- 3.2.7A Explain and apply scientific and technological knowledge.
- 3.2.7C Identify and use the elements of scientific inquiry to solve problems.

Learning Objectives

After this lesson, students should be able to:

- **Identify the concave and convex lens, and name their purpose in bending light (inversion and magnification).**
- **Appreciate the relationship between magnification and blur, and the application of eyeglass lenses (focusing lenses) to eliminate the blur and create a purely magnified image and extra gathered light.**
- **Use different "sized" lenses to create various telescopic effects, possibly identifying the ratio of the focal lengths of the objective and focusing lens to the magnification property of the telescope.**
- **Create a working telescope**
- **Synthesize the information to describe the workings of an overhead projector.**

Materials List

Each group needs:

- Black construction paper
- Flashlight
- Index card
- Ruler
- Aluminum foil tape (a roll of reflective foil tape can be purchased from Home Depot, $2.96 per roll)
- 1-liter soda bottle
- Scissors
- Exact-o knife
- Masking Tape
- Glue
- Paper towel roll & telescope supplies
- Plano-convex lenses
- Plano-concave lenses
- White paper

Introduction / Motivation

Procedure

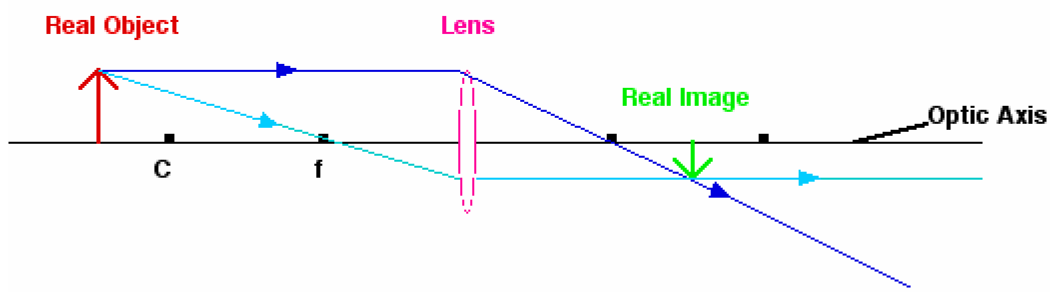
With the Students

1. Demonstrate a laser pointer light through chalk dust or a tub of milky water. Explain: light bends as it passes through water and milk based on the angle of incidence. Some refracts through (bends) and some reflects back. Alter the angle to the critical angle to show total internal reflection.
2. Show the students magnifying glasses and simple lenses. we will take advantage of light bending to be able to see. Seeing is simply gathering light information. Turn the lights

out – you can't see! This is how photography works, satellite dishes, mirrors, eyeglasses, and telescopes.

3. Explain: Think about eyeglasses or magnifying glass. It's bent. When an object bounces light through a convex lens, it bends more at the outer ends than the inner due to the shape, causing convergence but upside down! Convergence is good because the image will be sharp.

Convex (converging) Lens with object outside of the center of curvature



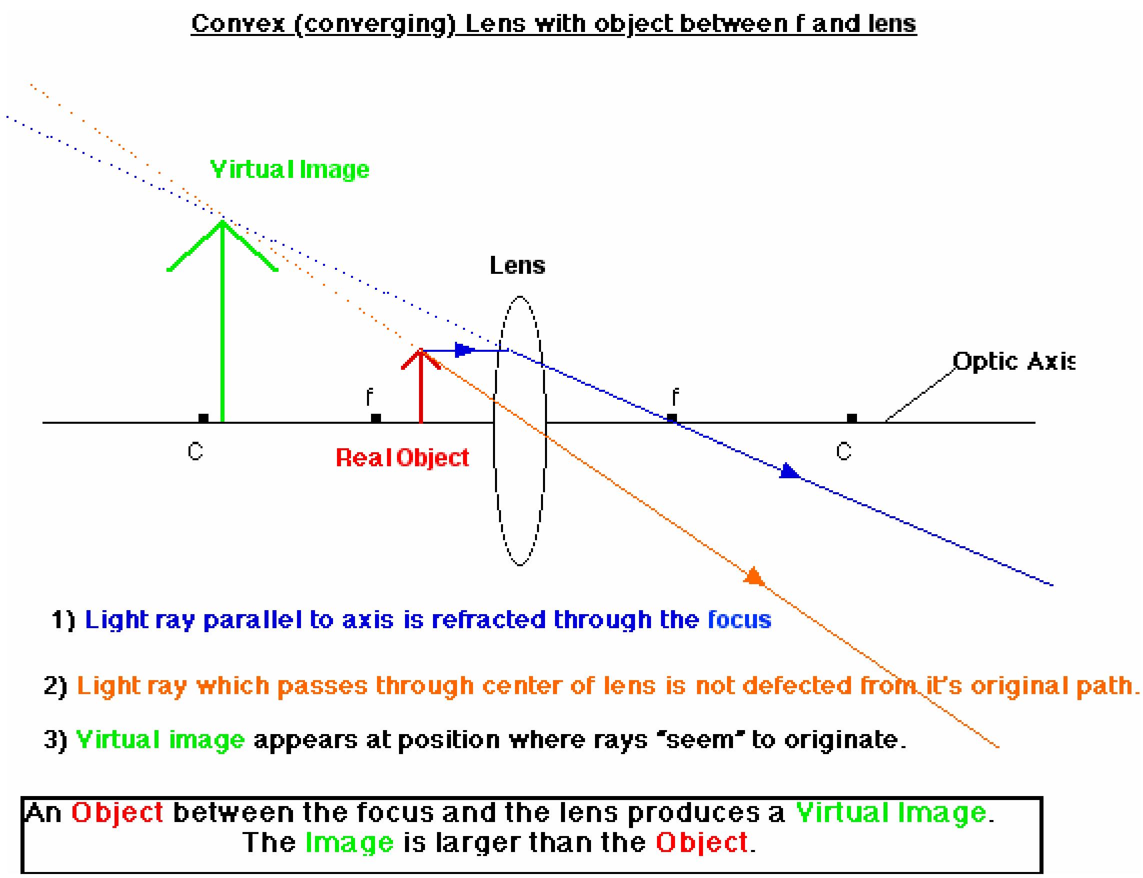
1) Light ray parallel to axis is refracted through the focus.

2) Light ray going through the focus is refracted parallel to the axis.

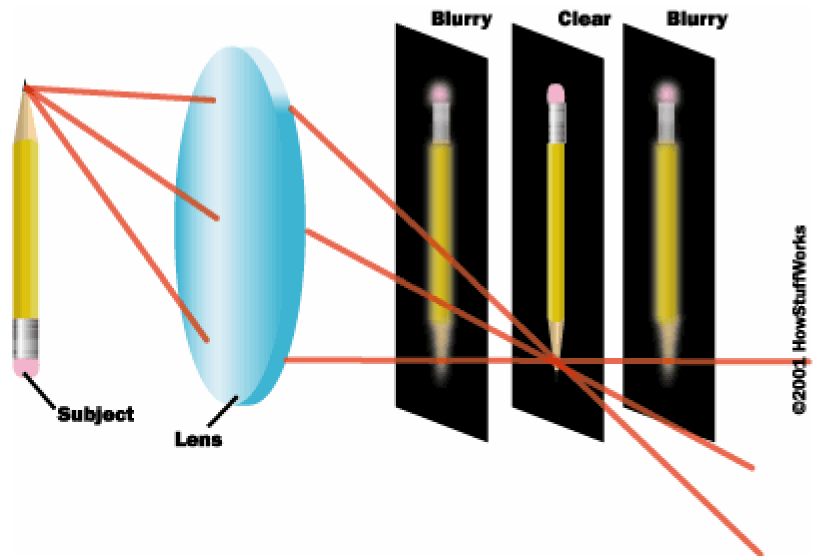
3) Real image is formed where the refracted rays meet.

*** Object outside C produces a real image between focus and C. ***
Image is smaller than Object.

4. Explain: notice the images are behind the lens! This is good for our eyeballs, but not so good if we're trying to read from a magnifying glass. Besides, we want the text to be rightside-up! If it's not flipped over, we're not getting a "real image." Sometimes this is good! Not good for telescopes though.



5. So convex lenses (called objective lens) help us collect light. Bigger lenses will collect more light, but at a distance they are too blurry. This is like the human eye! We correct it with eyeglasses! This will be our focusing lens, or eyepiece. On telescopes it's the same. We use a smaller lens to collect the converged light from the objective lens, flip it over again into our eye. This lens can be smaller because the light is already focused (draw picture). The smaller this lens compared with the objective lens, the more magnified the image will be. Larger focusing lenses will still de-blur the image, but will undo some of the magnification by diverging the rays again. Two lenses together magnify and remove blur, i.e. eyeglasses, camera. Move lens away to decrease blur at sweet spot when rays converge to same place.



6. How much is it magnified? The ratio of the focal lengths.
7. Make the lenses produce actual inverted images and then focus them! This is the basis of how we'll make our telescopes. By the way, the reason telescopes have eyepieces is because they use a mirror to reflect the focused light, because otherwise your head would get in the way of viewing.
8. Two lenses together magnify and remove blur, i.e. eyeglasses, camera. Move lens away to decrease blur at sweet spot when rays converge to same place. The focusing lens need not be so big though, and this cancels some (or any) of the magnification of the objective lens since we're not flipping it twice, hence focusing lens is virtual image. Focusing lens can be smaller because objective lens collected all the light and converged it due to convex shape. Talk about satellite dishes. Opposite in that light bounces not passes through, and hence concave shape acts as objective lens and converges (imaging throwing a bouncing ball at it) to the collector antenna, which acts as the focusing lens.
9. Stress the need to use convex lens to make image bigger. But it becomes blurry. Eye helps with this if you focus, but can only do so much. When rays don't converge to a point, they are blurry. Why concave image appears smaller? Because it's virtual and smaller inside. Convex virtual is also in front but enlarged, i.e. magnifying glass or close to text double-convex lens.
10. Create your own lens by cutting out a soda bottle, taping reflective tape to the inside, and shining light through slits in an index card just in front of the "lens." The light will pass through the slits in beams, and then converge on the focal point of the lens as a bright spot.
11. Experiment with the concave and convex lenses (and possibly magnifying glasses and eyeglass lenses) to produce an upright or inverted but magnified and clear image. The image magnifies with the convex lens but becomes blurry until a point at which it becomes a total blur and then inverts. Use a concave lens to remove the blur, just like eyeglasses.
12. Once the point of clarity and magnification is found, note that length and create a telescope from the paper towel rolls and lenses.

Assessment

Post-Activity Assessment

1. **Identify the concave and convex lenses, and name which [convex] makes an appropriate objective (collecting) lens and which [both] makes an appropriate focusing lens.**
2. **Describe the workings of an overhead projector, including why the image appears upright on the screen [bending light through the lens inverts to the mirror, which inverts again to the screen].**

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Owner

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