Lenses and Telescopes
Source: http://solar.physics.montana.edu

Activity:
Investigation of lenses and simple telescope construction.

Science Standards:
Energy & Matter, Systems & Interactions, and Scientific Models (Scale)

Objectives:

- Student will describe the nature of convex lenses.
- Student will measure the focal length of several lenses.
- Student will describe real and virtual images.
- Student will construct a simple refracting telescope.

Materials:

- two lenses per group (one thin and one thick convex lens)
- meter stick
- 2 styrofoam cups of identical height for each group
- curved glass jar filled with water (one for the class)
- newspaper
- masking tape
- copies of student answer sheets for each student

Introduction:
1. Describe the devices which use lenses.
2. Determine how different lenses affect vision.
3. Measure the focal length of two lenses.
4. Construct a refracting telescope.
5. Complete the student answer sheets.

Lenses and Telescopes - Student Answer Sheet

Directions: Answer the following questions as accurately as possible. Try to use complete sentences and thorough explanations. The questions are very general and may or may not have correct answers - the questions are to serve as a guide to your exploration.

EXPLORATION
What are some things that use lenses?

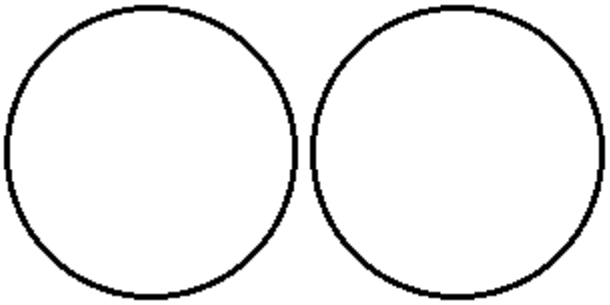
How do lenses differ from each other?

Why do you think that some lenses magnify more than others?

CONCEPT INTRODUCTION
Look at the lenses at your lab table. *Label* the lens which is most curved (we say a thick lens is a curved lens) as lens **A** and the lens which is least curved as lens **B** using a pen and some masking tape. Place the tape-label on the side of the lens so that you can still look through the lens.

1. Use lens A to look at the writing on this page. Now use lens B. Which lens makes the letters appear larger?

2. Look at the prints and patterns on your index finger using both lens A and lens B. In the circles below, carefully draw what you can see in detail.



Lens A Lens B

3. Hold lens A and lens B close to the letters on this page. Does the writing appear right side up or upside down?

4. Hold one of the lenses close to your eye. Slowly move the lens closer and closer to the page until the letters become clear. Do the letters appear right side up or upside down?

At the front of the room, there is a clear container of water which is curved. What happens when you look at an object *through* the water?

What do you think is the definition of *magnifying power* ?

What do you think is meant by the term *field of view* ? Does a lens which magnifies greatly have a large or small field of view?

While keeping the the lens at approximately 10 cm from your eye, slowly move the lenses closer and farther away from this page. Are there any differences between what you see at close, medium, and long range?

What happens if you do this experiment with your (or your partner's) eyeglasses?

A lens has a characteristic feature called a focal length. The **focal length** is the distance away from the lens that it will focus light. While sitting underneath a ceiling light in the room or against a wall opposite a window, *measure how far above the paper you must hold the lens* to focus image of the overhead lights or objects outside the window.

What is the focal length for lens A (in cm)?

What is the focal length for lens B (in cm)?

Did the lens with the most magnification have the greatest focal length?

Attach the lenses to a styrofoam cup or optical bench such that you can align the lenses in a straight line such that you have a telescope. *Separate the lenses by a distance of the sum of their focal lengths* . This kind of telescope is called a *refracting telescope* .

Focal length of lens A + Focal length of lens B = Distance between lenses in a telescope.

+ _____ = _____ cm

What can telescopes be used for?

CONCEPT APPLICATION
A telescope uses two lenses. The lens which is closest to your eye is called the **eyepiece** lens and the lens which is closest to the object at which you are looking is called the **objective** lens.

Note which lens is the objective lens and which is the eyepiece lens by drawing a detailed diagram of your telescope below (be sure that you label which lens is which).

Describe what you see with your telescope. Can you alter the image by rotating or spinning the lenses?

Now switch the positions of the lenses A and B. Is what you see any different?

Which arrangement makes the most powerful telescope?

Which arrangement makes the telescope have the widest field of view?

When objects are viewed through your telescope, are they right-side-up or up-side-down? Why?

How far away can you read a newspaper with your telescope?