PHY138 – Waves, Lecture 8
Today's overview:

- Dispersion and Rainbows
- Lenses
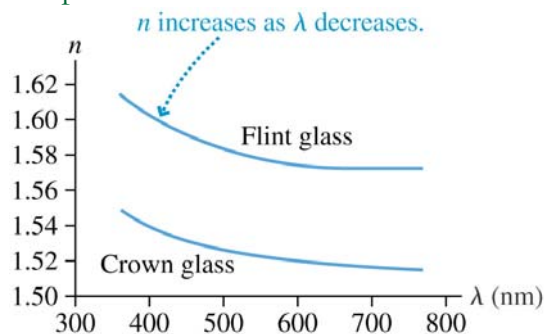- The Thin Lens Equation
- Lenses used in Combination

Course Evaluations in Tutorial this week!

- Your chance to officially evaluate Professor Harrison and me is this week during tutorial.
- Your comments will make it into the 2007-08 Anti-Calendar and will form part of my tenure-review in 2009.
- You participation and honest comments are appreciated – we will read them in the summer after the marks have been submitted.
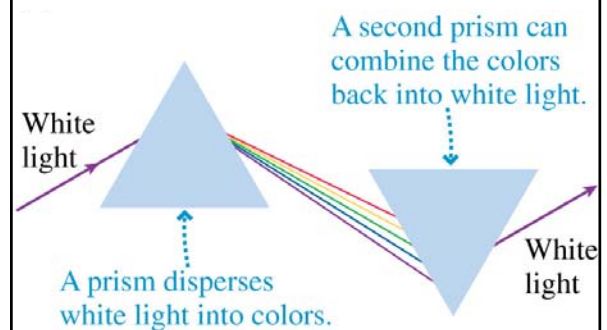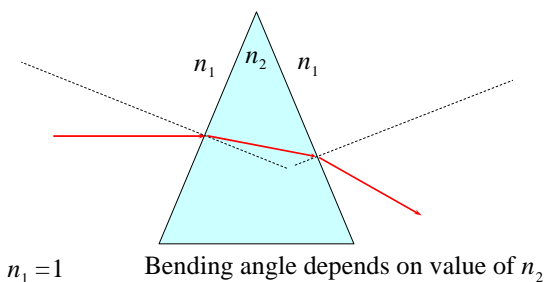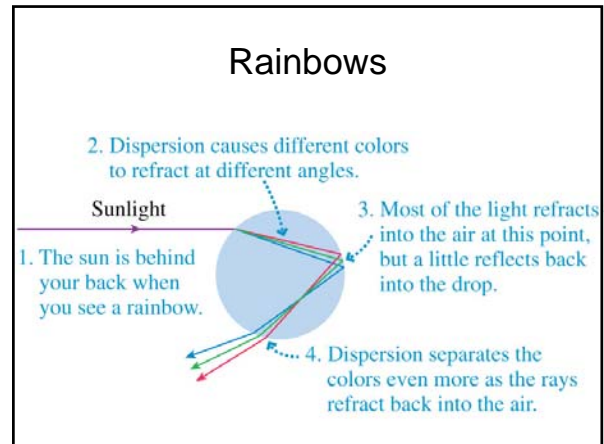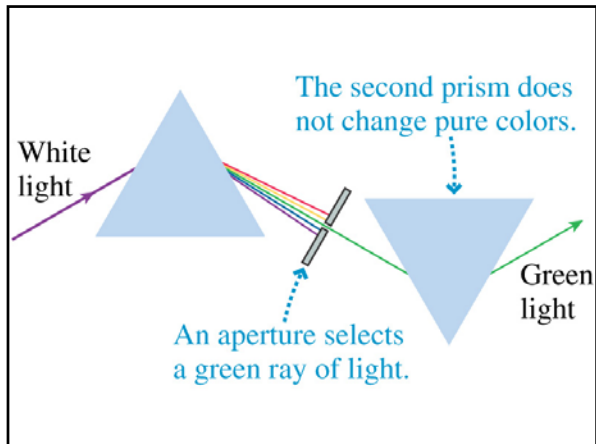

Second **Representative Assembly** Friday!

- Friday, Dec.1 at 2:00 PM in MP222
- One or two "representatives" from each tutorial group are invited. (Please select yourselves during tutorial.)
- *Refreshments will be provided!*
- I will be there and I'm interested in hearing your thoughts on issues of communication and structure of this course.
- Professor Strong will be there – she's your next prof in this course!

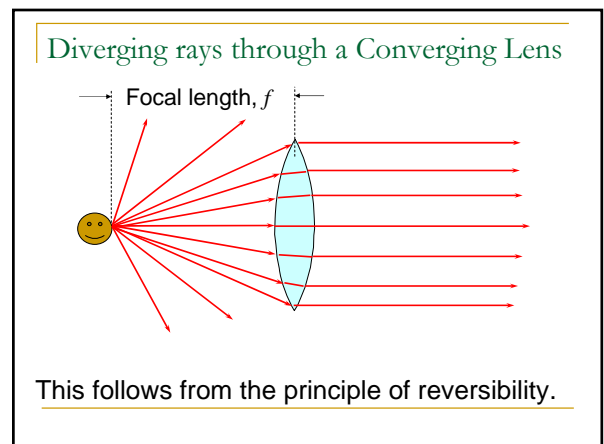## Dispersion

n increases as λ decreases.

Flint glass

Crown glass

Light going through a prism bends toward the base

n_1 n_2 n_1

$n_1 = 1$ Bending angle depends on value of n_2

A second prism can combine the colors back into white light.

White light

A prism disperses white light into colors.

White light

White light

The second prism does not change pure colors.

An aperture selects a green ray of light.

Green light

Rainbows

2. Dispersion causes different colors to refract at different angles.

Sunlight

1. The sun is behind your back when you see a rainbow.

3. Most of the light refracts into the air at this point, but a little reflects back into the drop.

4. Dispersion separates the colors even more as the rays refract back into the air.
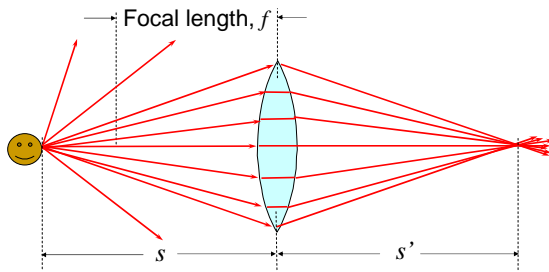
Lenses

- Formed by two curved boundaries between transparent media.
- Lenses often have spherical surfaces (lens-maker's equation). The curved surfaces are parts of large spheres of radius R_1 or R_2.
- **Every** lens shaped like a circle has a diameter, D, and focal length, f.
- The ratio of (f/D) is called "f-number". For example, an "f/6" lens has a focal length of 6 times its diameter.

Converging Lens

Focal length, f

Focal Point

NOTE: Focal length is defined for initially parallel rays.

Diverging Lens

Negative Focal length, $-f$

Virtual Focal Point

Rays appear to emerge from Virtual Focal Point

Diverging rays through a Converging Lens

Focal length, f

This follows from the principle of reversibility.

Diverging rays through a Converging Lens

Focal length, f
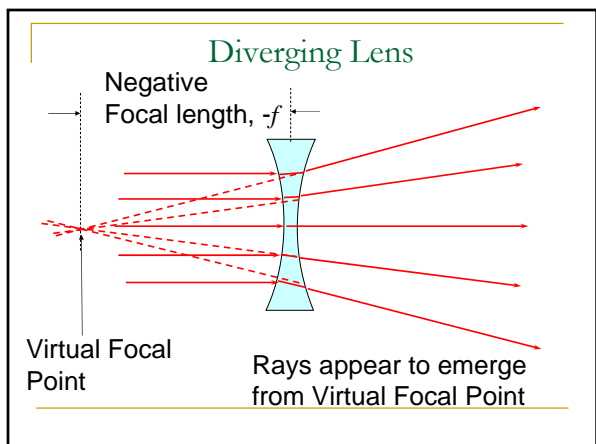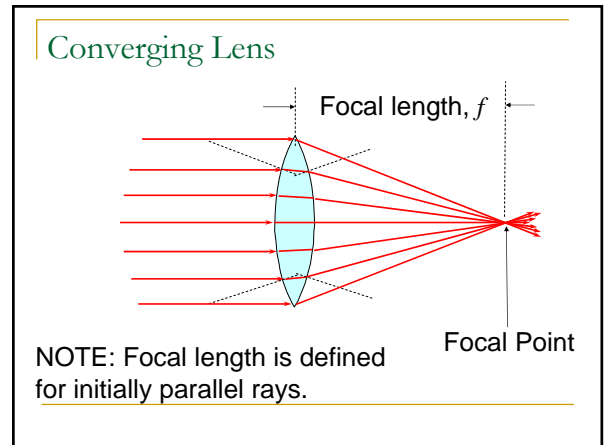
s s'

Thin Lens Equation: $\dfrac{1}{s} + \dfrac{1}{s'} = \dfrac{1}{f}$

Thin Lens Equation: sign conventions

object   image

f

s s'
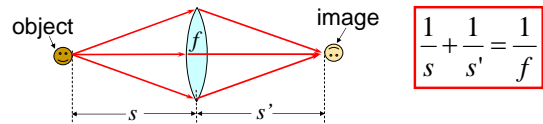
$\dfrac{1}{s} + \dfrac{1}{s'} = \dfrac{1}{f}$

s is positive for objects to the left of lens, negative for objects to the right of lens (virtual objects).

s' is positive for images to the right of lens, negative for images to the left of lens (virtual images).

f is positive for converging lenses, negative for diverging lenses.

Lenses used in combination

- If one or more lenses are used in combination, the object of the second lens is the image of the first lens.
- The thin lens equation can be applied to several lenses in sequence, always setting the image of the previous lens to be the object of the next.