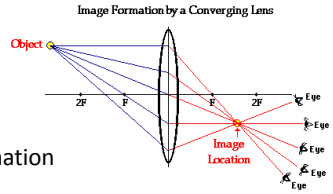
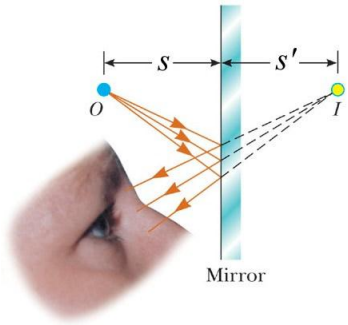
PHY385-H1F Introductory Optics

Class 9 – Outline: Sections 5.1, 5.2

- Geometrical Optics Introduction
- Refraction at a Curved Surface
- Thin Lens Equation
- Focal Point
- Focal Plane
- Images
- Magnification
- Lenses in Combination

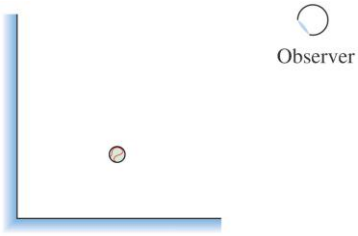


How an image is formed



Discussion Question…

Two plane mirrors form a right angle. How many images of the ball can you see in the mirrors?

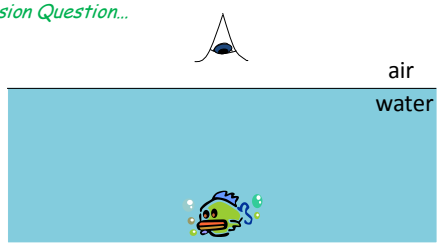


Discussion Question…

A fish swims below the surface of the water. An observer sees the fish at:

1. a greater depth than it really is.
2. its true depth.
3. a smaller depth than it really is.

Discussion Question…



A fish swims *directly* below the surface of the water. An observer sees the fish at:

1. a greater depth than it really is.
2. its true depth.
3. a smaller depth than it really is.

Image Formation from a Plane Surface

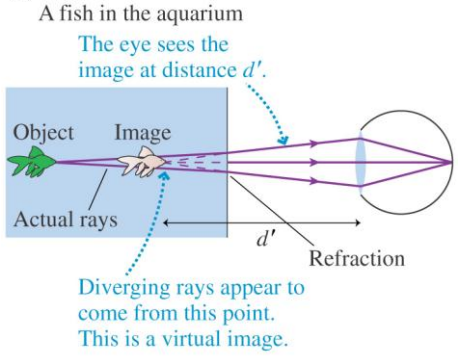
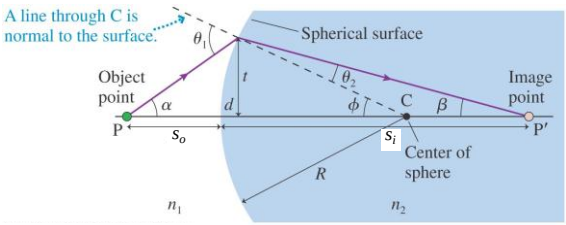


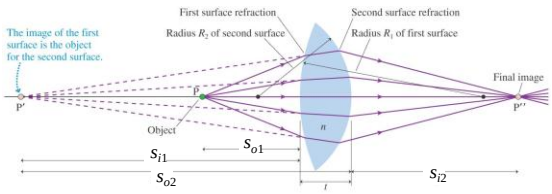
Image formation at a spherical interface



$$\frac{n_1}{s_o}+\frac{n_2}{s_i}=\frac{n_2-n_1}{R}$$

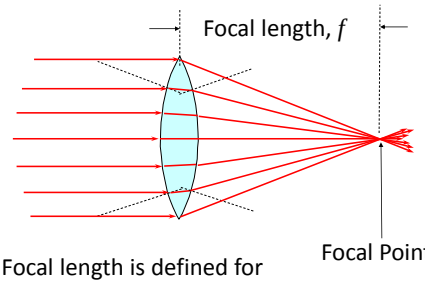
R is positive means surface is convex toward the object
R is negative means surface is concave toward object
s_o is positive means object is to the left of interface
s_i is positive means image is real, to the right of interface

Lensmaker's Formula



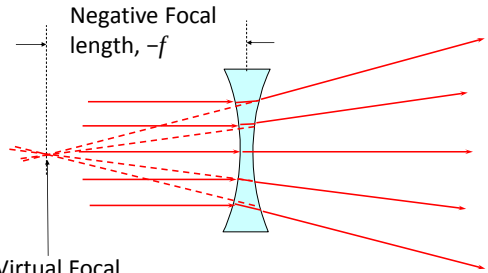
$$\frac{1}{s_{o1}}+\frac{1}{s_{i2}}=(n_l-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

Converging Lens



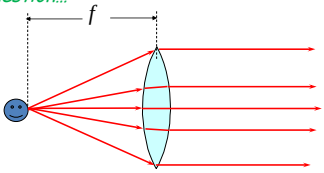
NOTE: Focal length is defined for initially *parallel* rays.

Diverging Lens



Rays appear to emerge from Virtual Focal Point

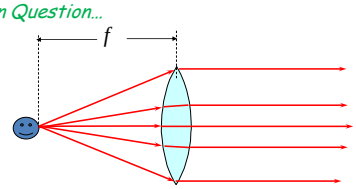
Discussion Question…



What will happen to the rays emerging to the right of the lens if the face is moved a little *closer* to the lens?

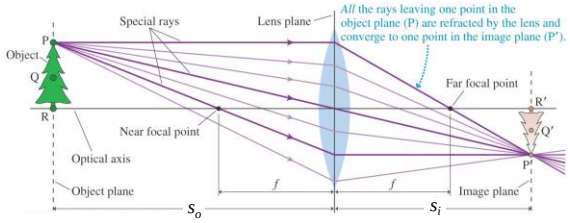
1. They will remain parallel.
2. They will diverge (spread out).
3. They will converge (toward a focus).

Discussion Question…



What will happen to the rays emerging to the right of the lens if the face is moved a little *further away* from the lens?

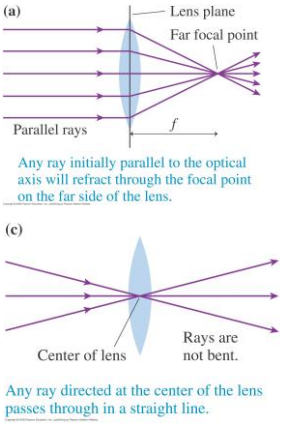
1. They will remain parallel.
2. They will diverge (spread out).
3. They will converge (toward a focus).



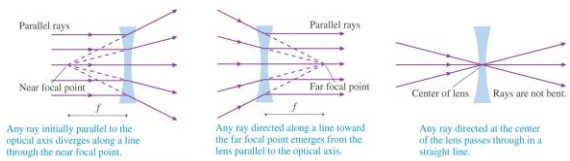
The Thin Lens Equation: $$\frac{1}{s_o}+\frac{1}{s_i}=\frac{1}{f}$$

f is positive for a converging lens
f is negative for a diverging lens
s_o is positive means object is real, to the left of lens
s_i is positive means image is real, to the right of lens
s_i is negative means image is virtual, to the left of lens

Ray Tracing
With a converging thin lens



Ray Tracing
With a diverging thin lens



Thin Lens Combinations