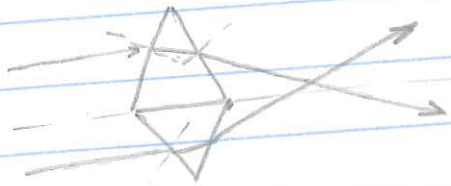
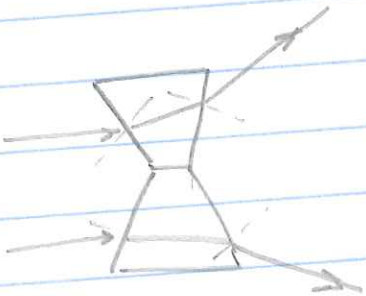
Reminder: a flat slab of material displaces beams, without changing their directions.

A prism can bend them



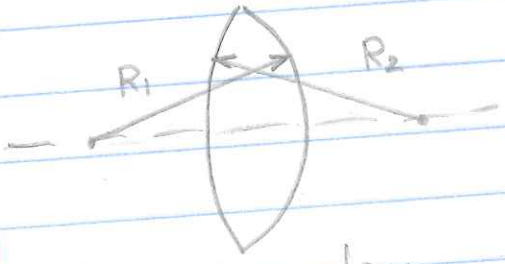
beams are directed toward the center (converging)



beams are directed away from the center (diverging)

Typical lens consists of two pieces of a spherical surfaces, or one flat and one sperical surfaces

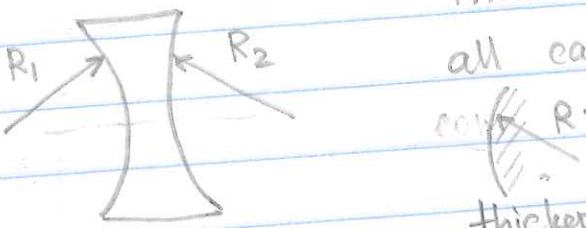
An optical axis passes through the centers of the two "spheres"



converging lens

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

This formular works for all cases, but



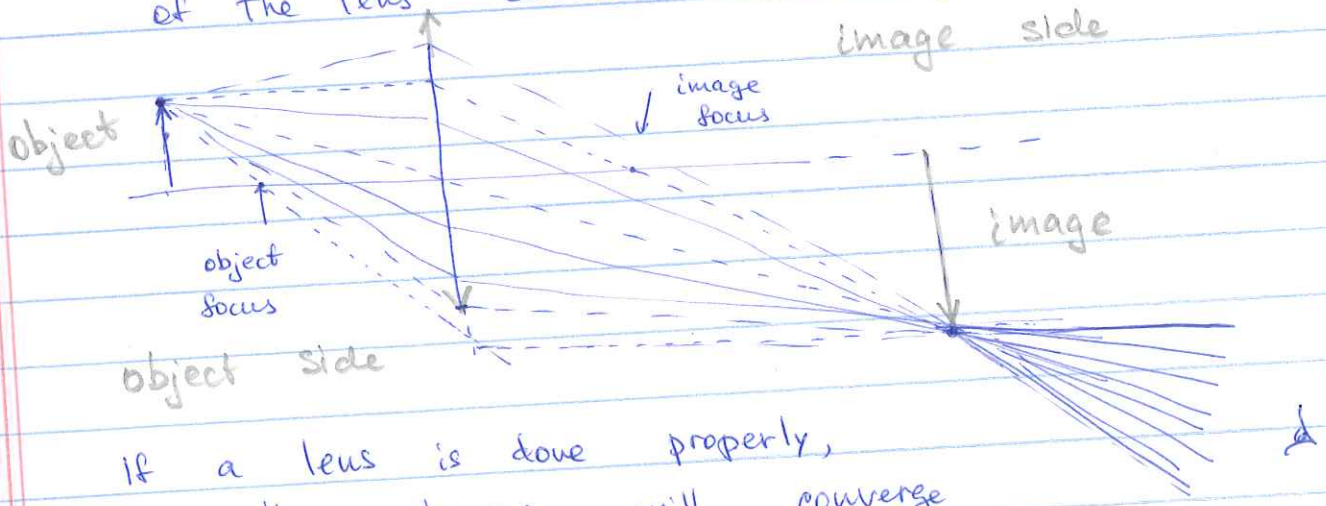
diverging lens

thicker at the center

thinner at the center

For calculations we are going to ~~to~~ think about ideal thin lenses. How do we know where the image is going to be

1. a beam which is parallel to the optical axis will go through the image focus
2. a beam which ~~originates~~ crosses the object focal point is going to continue parallel to the optical axis
3. The beam that travels through the center of the lens continues unchanged



If a lens is done properly, all the beams will converge in a point

On a computer make diagrams for more points to show how the image is formed.

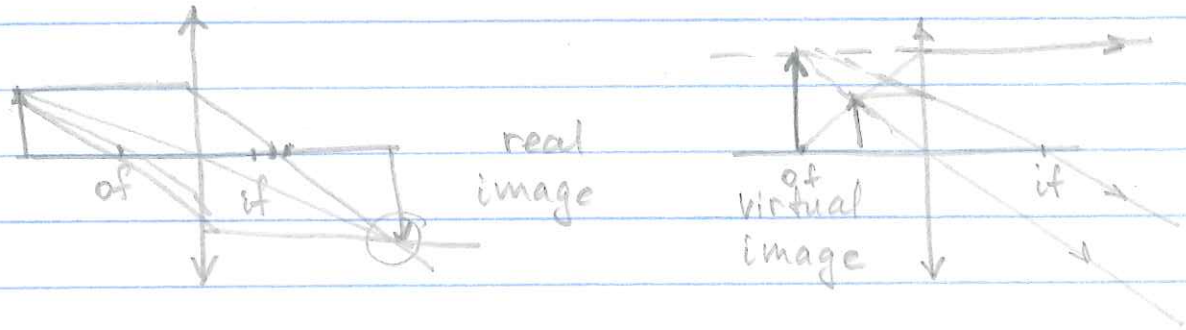
lens equation

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$$

$$m = -\frac{d_i}{d_o} = \frac{h_i}{h_o}$$

If the rays emitted from an object converge after lens, they form a real image

If they do not converge, but can be traced back to a point behind the lens, they form a virtual image



Lens formula

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$$

d_o – distance from the lens to the object

d_i – distance from the lens to the image

d_o, d_i, f can be both positive or negative

$d_o > 0$ an object is on the object side

$d_i > 0$ an image is on the image side

$d_i < 0$ an image on the object side

For the positive lens $f > 0$, so an object/image focus are at the correspondiy side; for a negative lens an object focus is on the image side, (after the lens) and the image focus is on the object half.