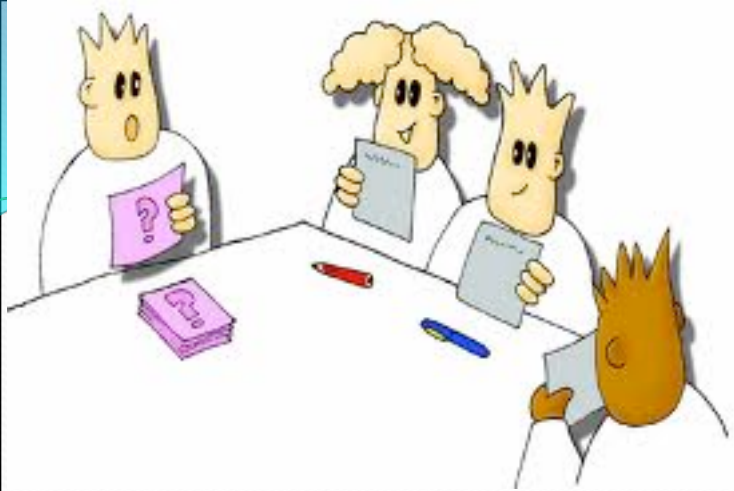


Lenses: Day 1





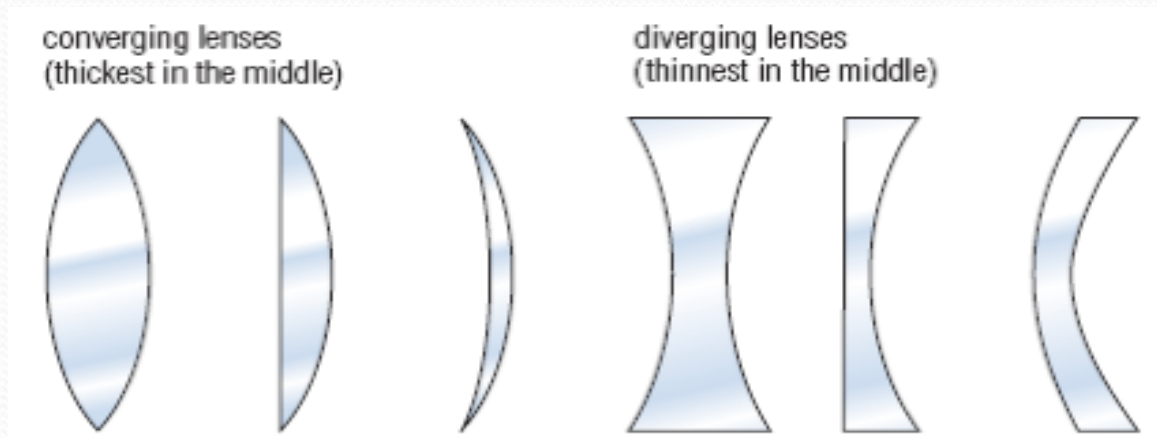
1. What is a lens
2. List as many devices you know that use one or more lens.
3. What does a lenses do?

Types of Lenses

- **uses:** microscope, telescope, binoculars, or a camera
- A **lens** is a curved transparent material that is smooth and regularly shaped
- **The light refracts in a predictable and useful way.**
- Most lenses are made of transparent glass or very hard plastic.

Types of Lenses

- it is possible to make light rays diverge or converge as they pass through the lens.
- light rays that refract through them can be used to magnify or project images



Types of Lenses

- Relative to the object, the image produced by a thin lens can be real or virtual, inverted or upright, larger or smaller.

converging lenses
(thickest in the middle)



diverging lenses
(thinnest in the middle)



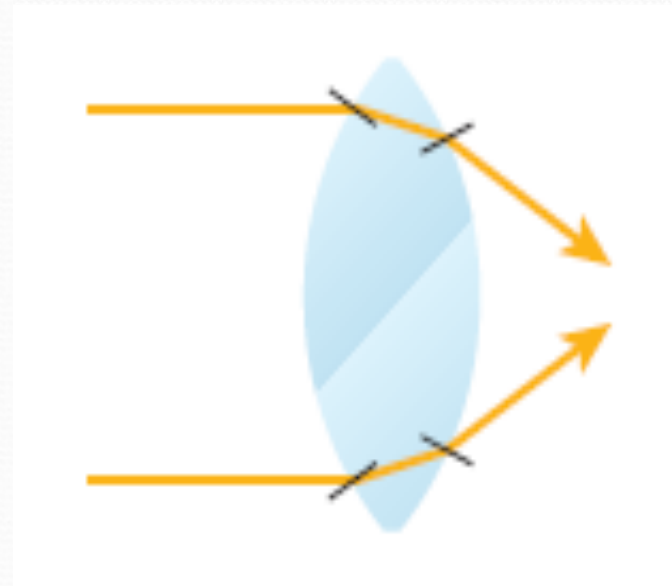


REMEMBER!

- **The index of refraction of a lens is greater than the index of refraction of air**

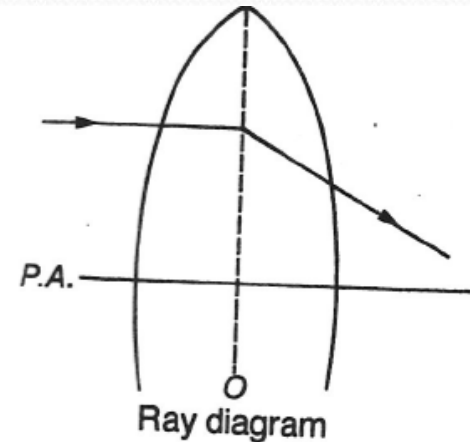
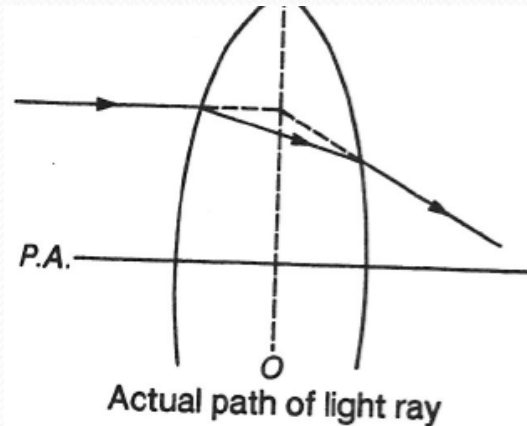
Light Rays and Refraction

- Light rays entering lenses will refract toward the normal.
- Exiting light rays will refract away from the normal.
 - **The light rays undergo two refractions, the first on entering the lens and the second on leaving the lens**



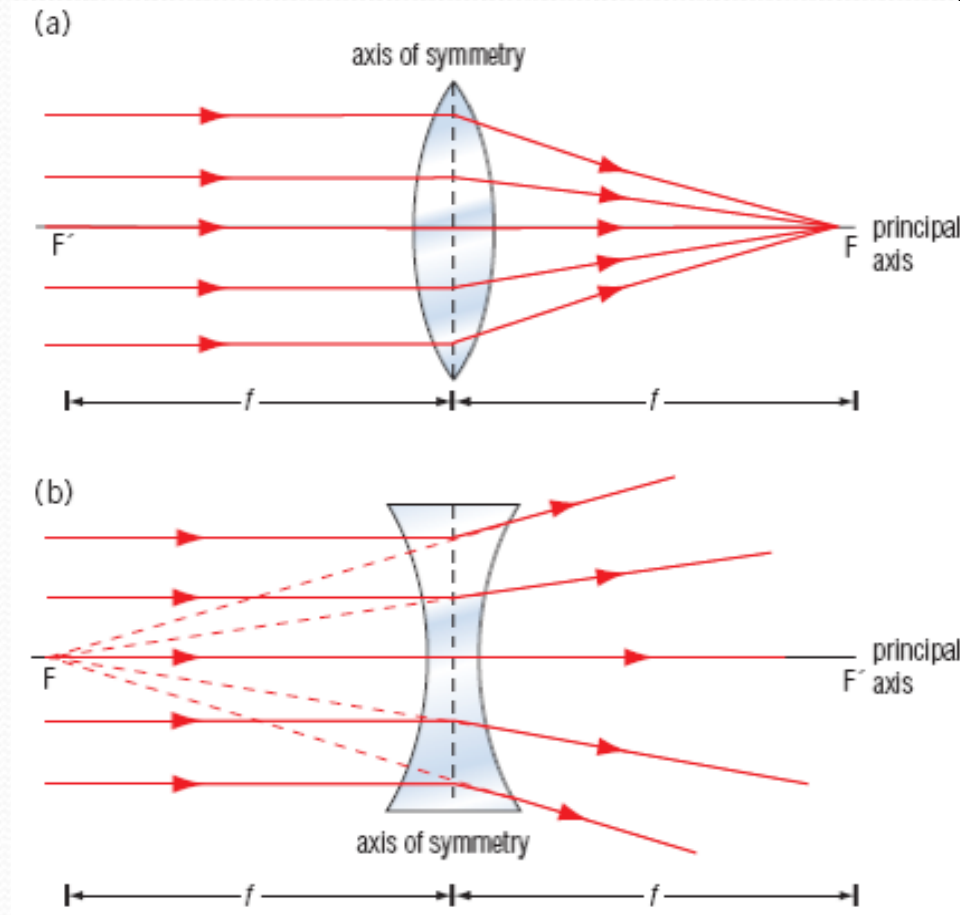
Drawing a Ray Diagram for a Lens

- **Thin lens** have a thickness that is slight compared to its focal length.
- An example-eyeglass lens.
- draw a ray diagram of a thin lens by assuming that all the refraction takes place at the axis of symmetry.



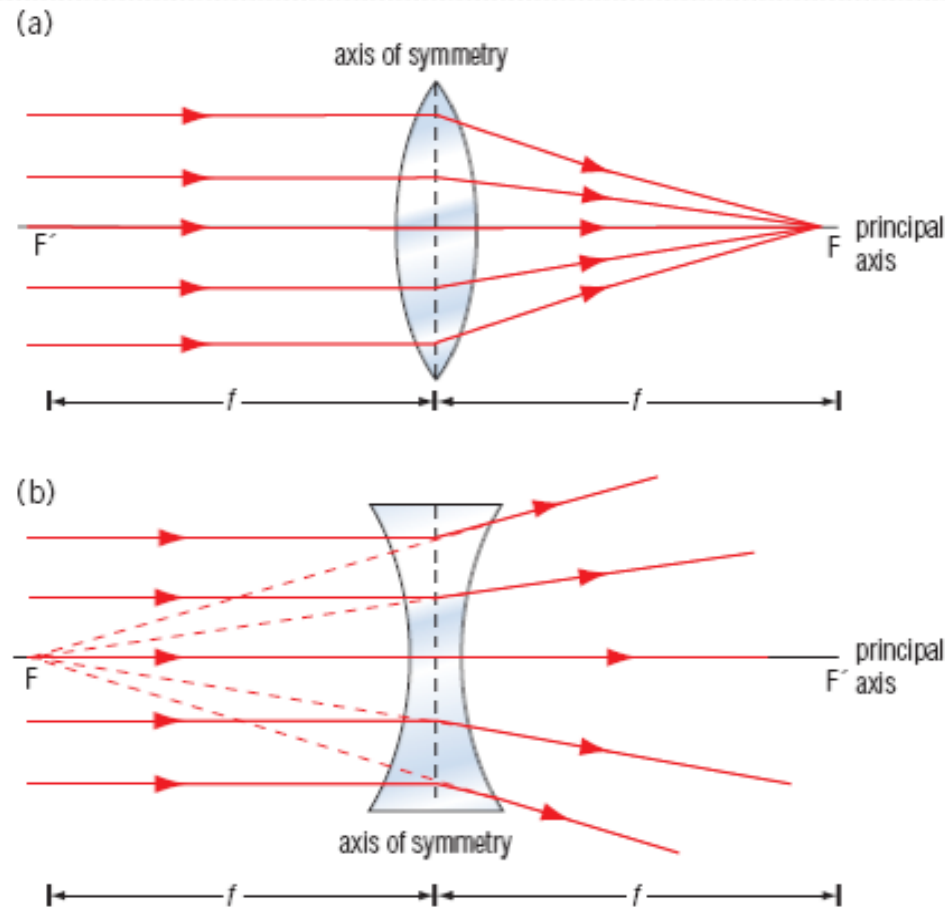
Lens Terminology

- The **principal axis** - a perpendicular line drawn through the optical centre.
- The **axis of symmetry** is a vertical line drawn through the optical centre of a lens.



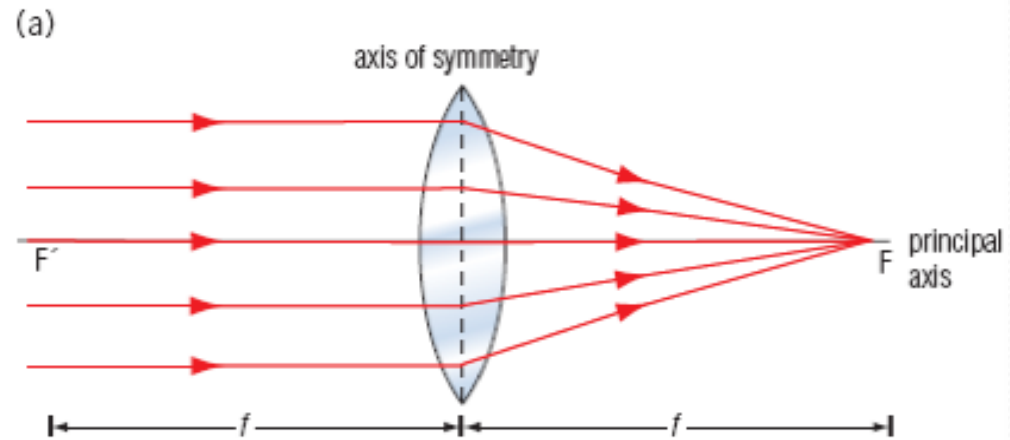
Lens Terminology

- Both kinds of lenses have two **principal focuses**.
- The focal point where light focus or diverges from
- **F** on one side of the lens, **F'** on the other side.



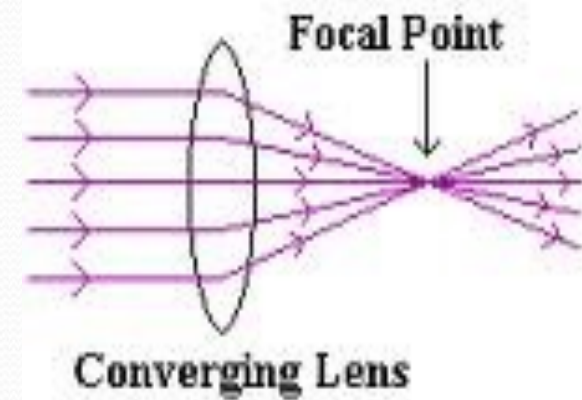
Lens Terminology

- The focal length, f = distance from the axis of symmetry to the focus.
- lenses have two equal focal lengths.



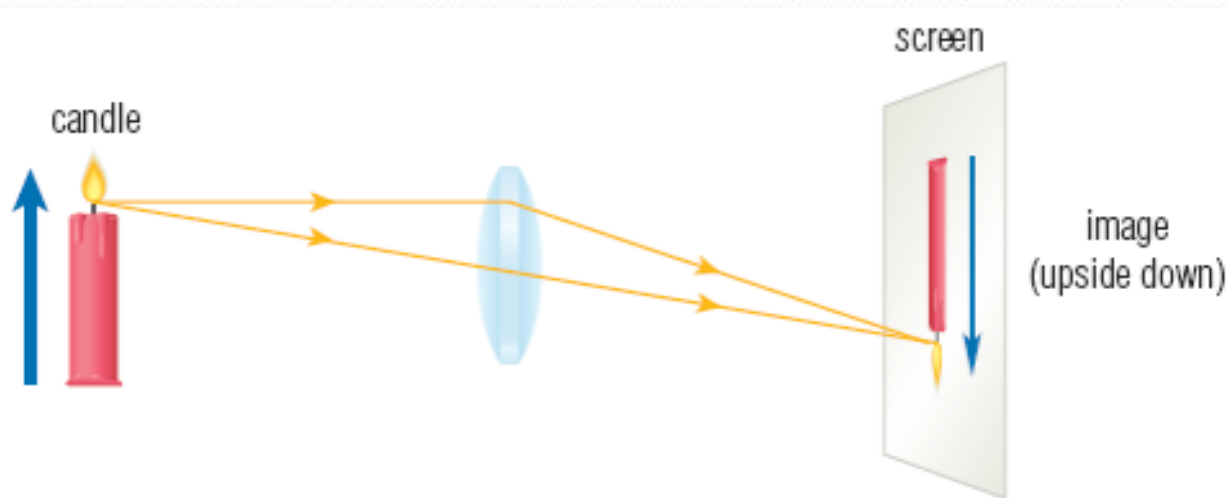
Convex Lenses

- A **converging lens** is also called a **convex lens**
- As parallel light rays travel through a convex lens, they are refracted toward the principal axis.
- This causes the rays to move toward each other. The light rays cross at the focal point of the lens.
- **Converging lenses are often used as magnifying glasses**



Forming a Real Image During Reading

- Convex lenses are useful because they can form a real image on a screen.
- The screen must be placed where light rays converge. This is the point where rays come to a single point.
- **When the rays from every point on the candle are sent to the screen, a complete image is formed.**

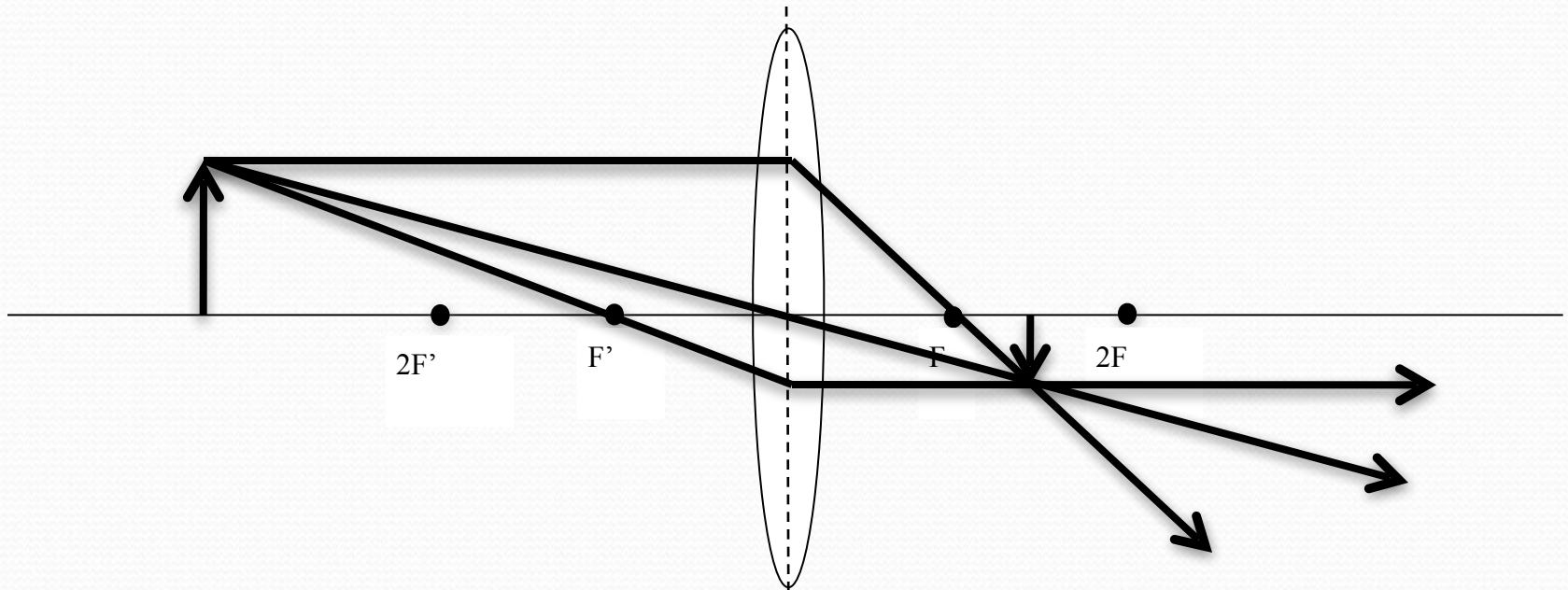


Drawing a Convex Lens Ray Diagram

1. Any ray that is parallel to the principal axis is refracted through the principal focus (F).
2. A ray that passes through the secondary principal focus (F') is refracted parallel to the principal axis.
3. A ray that passes through the optical center goes straight through, without bending

As with converging mirrors, only two rays are required to locate an image. The third one acts as a check

Object beyond $2F'$ (An object more than two times the distance of the focal length from the lens)



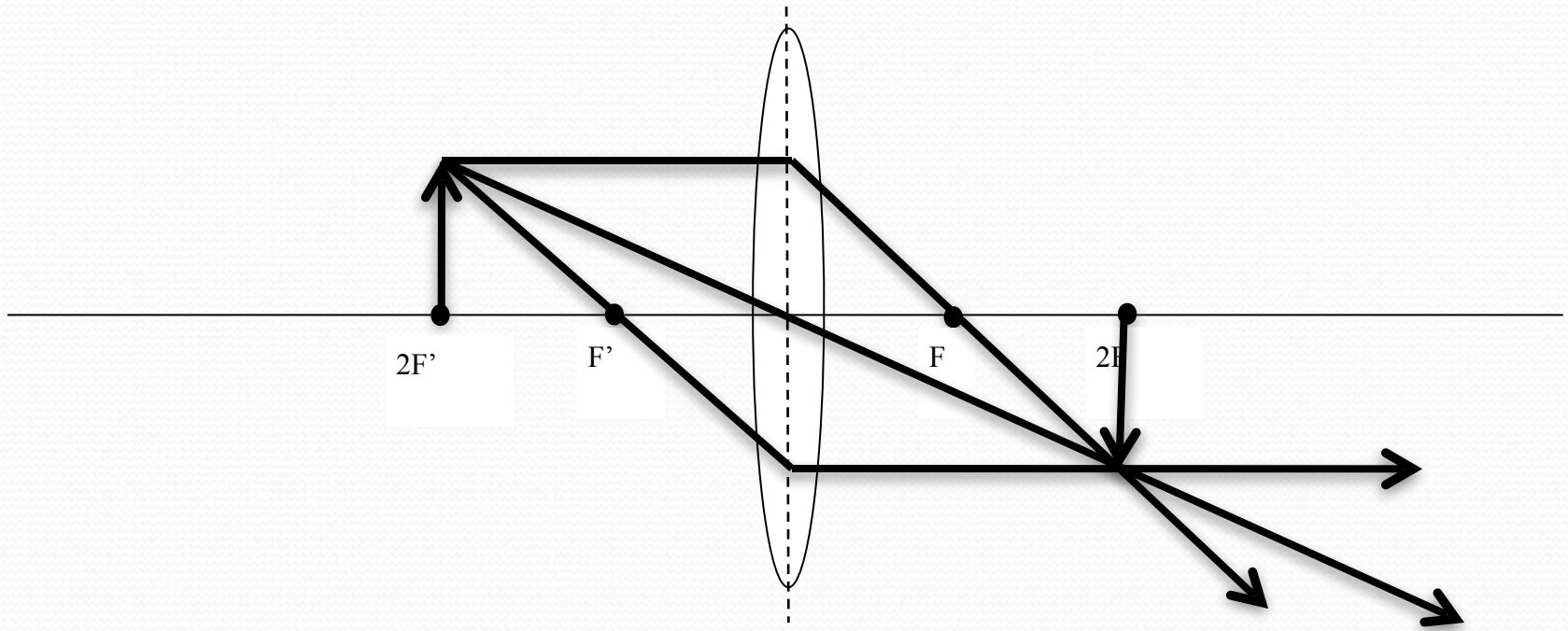
S: Smaller

A: Inverted

L: Between F
and $2F$

T: Real

Object at $2F'$



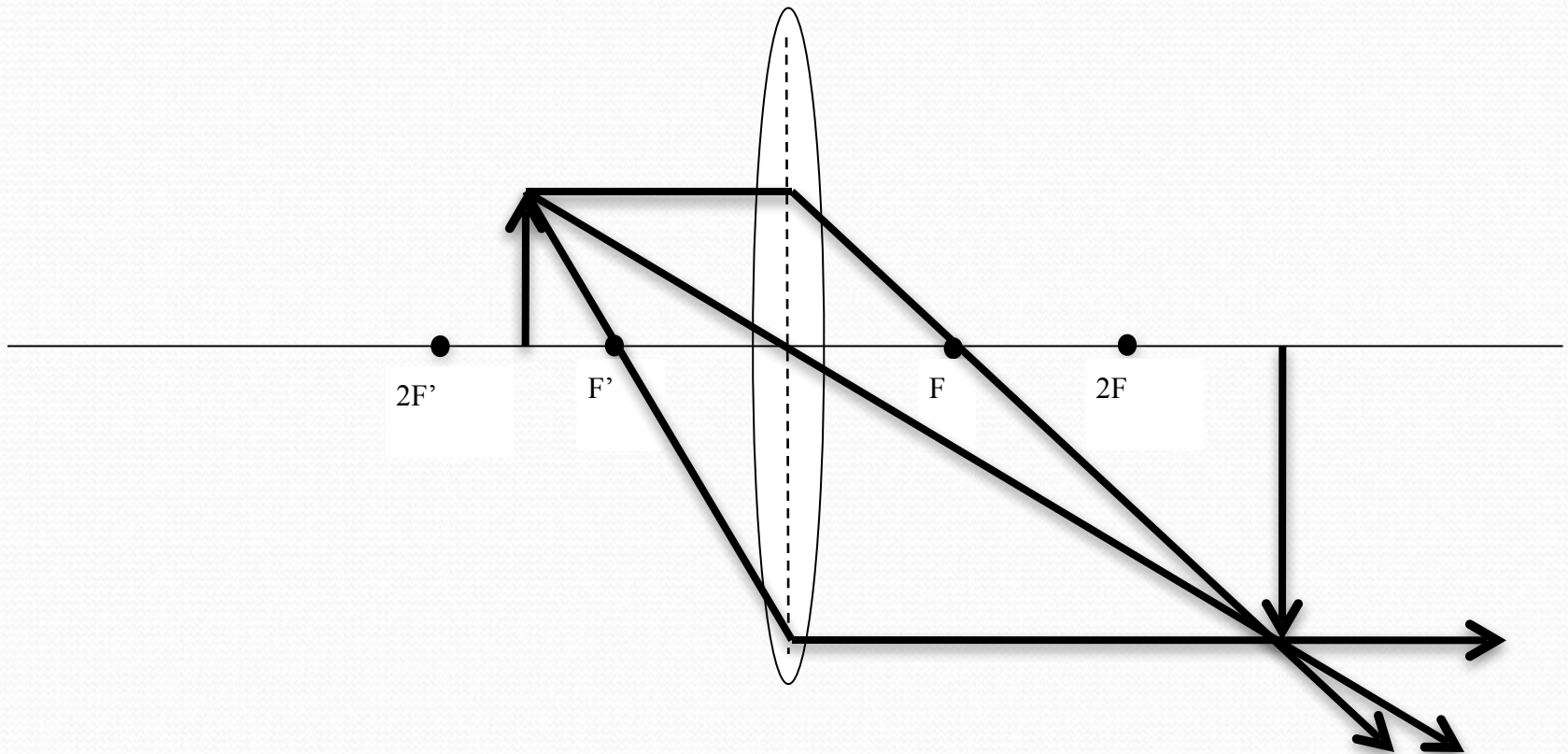
S: Same size

A: Inverted

L: At $2F$

T: Real

Object between $2F'$ and F'



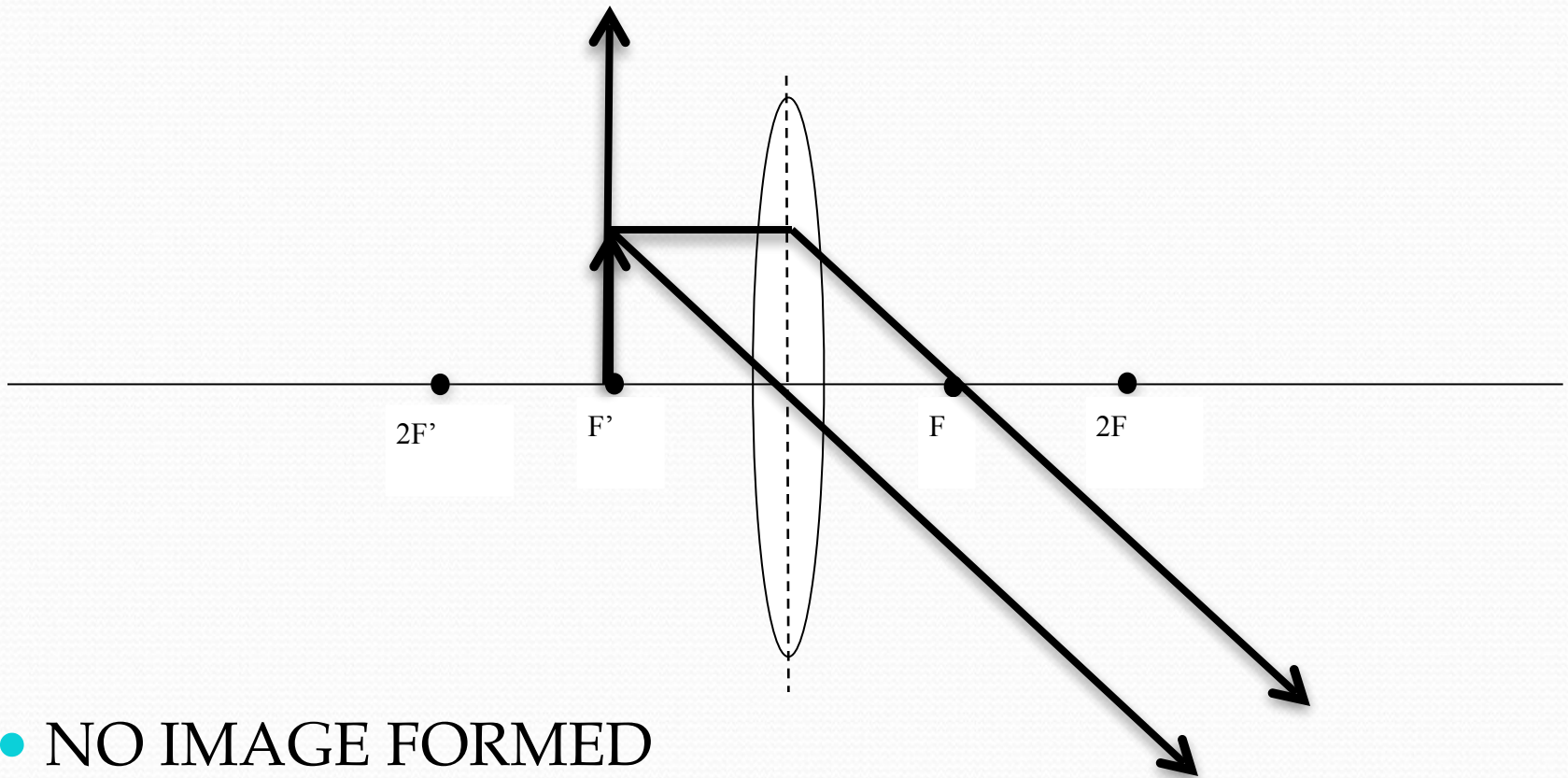
S: Larger

A: Inverted

L: Behind $2F$

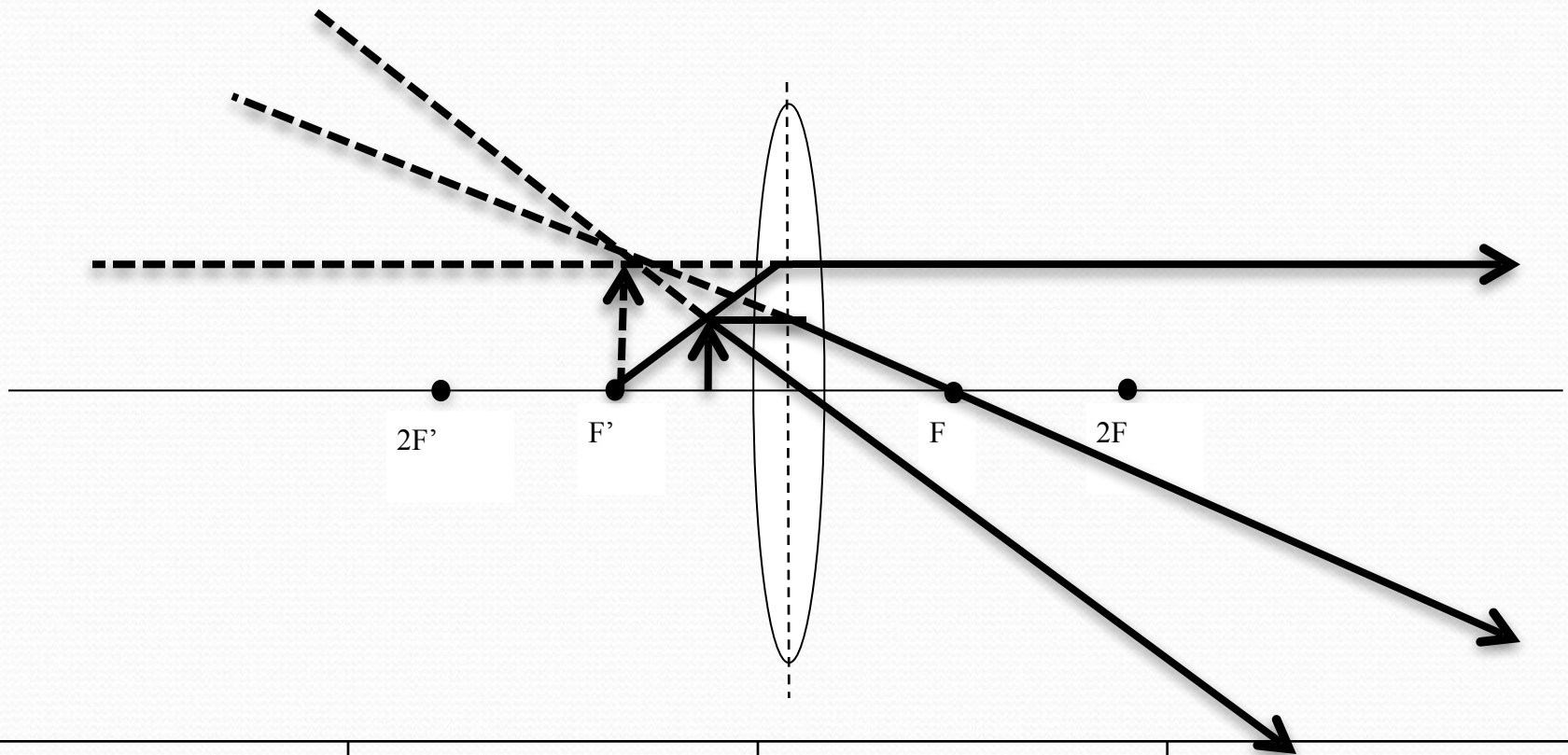
T: Real

Object at F'



- NO IMAGE FORMED

Object in front of F'



S: Larger

A: Upright

L: Behind F'

T: Virtual

Convex Lenses

Distance of Object from Lens	Type of Image Formed	How Image Is Used	Ray Diagram
More than two focal lengths	Smaller, inverted, real	A camera uses this distance to make smaller images of an object.	
Between one and two focal lengths	Larger, inverted, real	Photographic enlargers, slide projectors, and movie projectors use this distance.	
Less than one focal length away	Larger, upright, virtual	Magnifying glasses and reading glasses make use of this distance.	