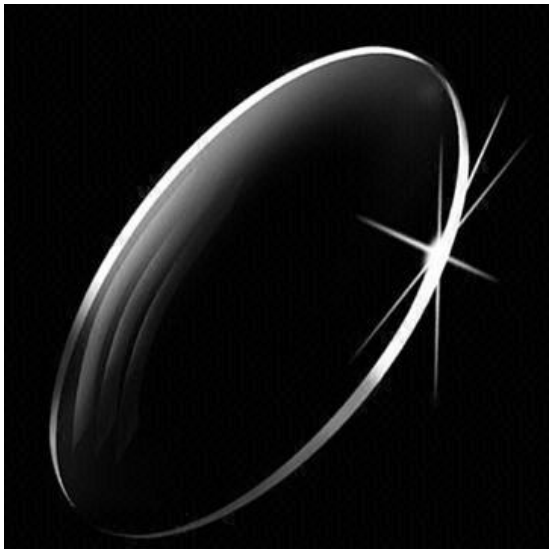
Lens Basics

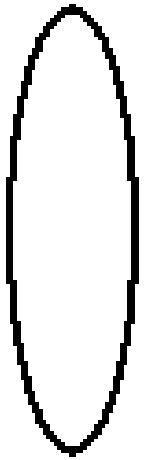
- A lens is merely a carefully ground piece of transparent material which refracts light rays in such a way as to form an image.



Types of Lenses

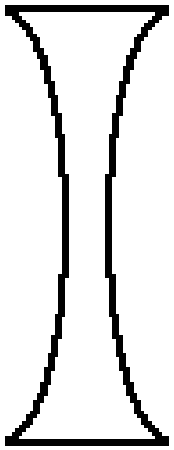
- There are two types of lenses.

Convex Lens
(Converging)



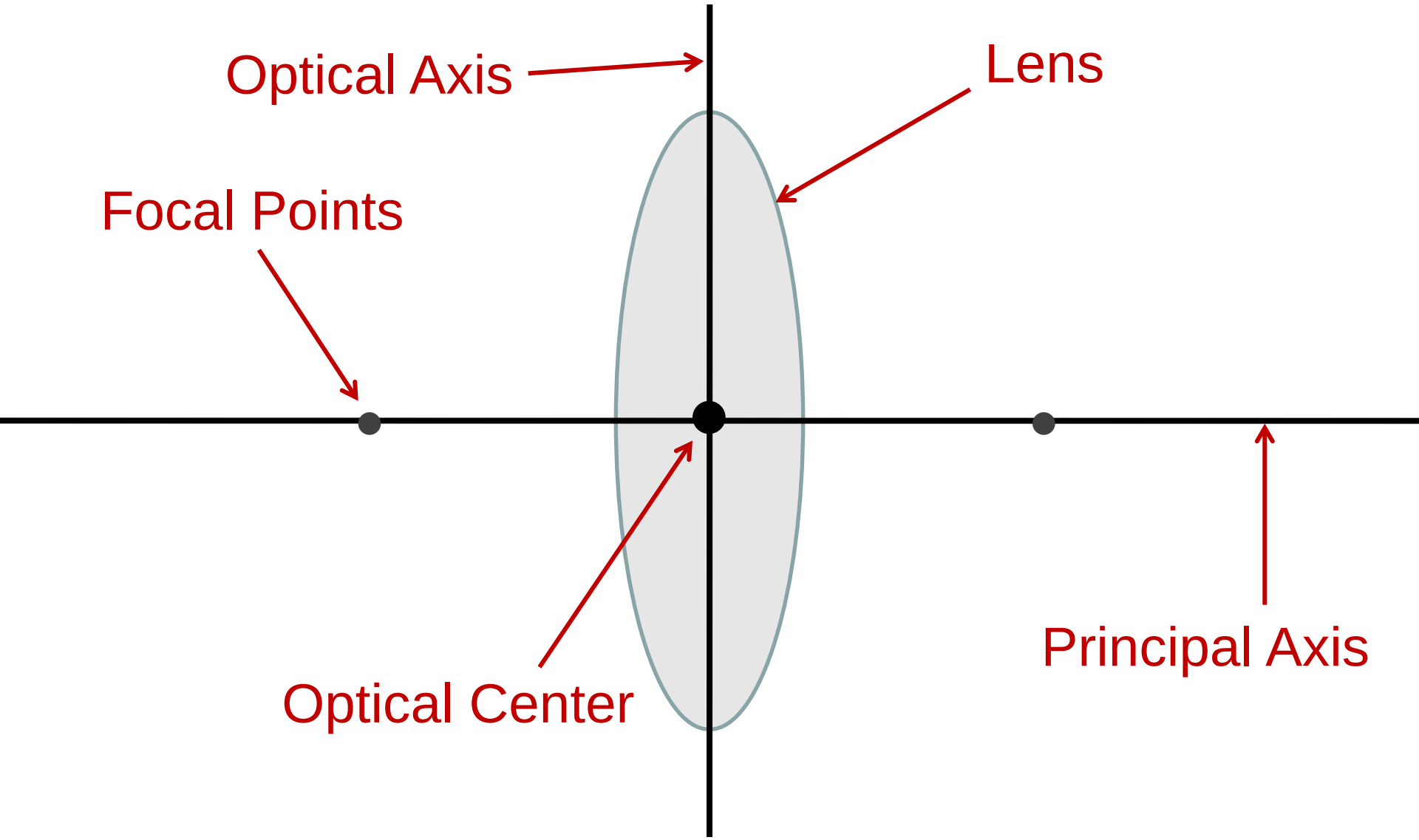
Thicker in the middle than at the ends

Concave Lens
(Diverging)

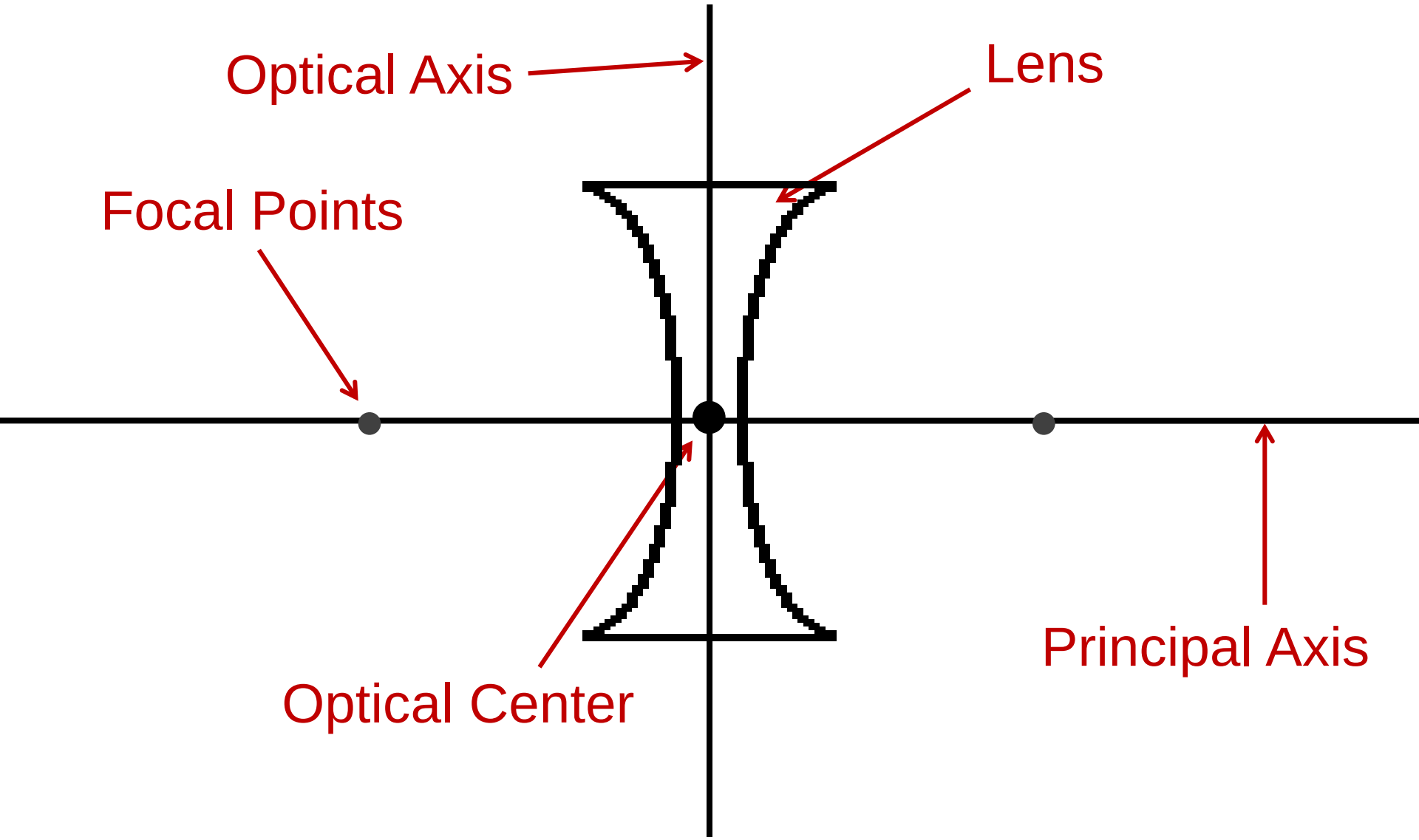


Thinner in the middle than at the ends

Anatomy of a Lens



Anatomy of a Lens



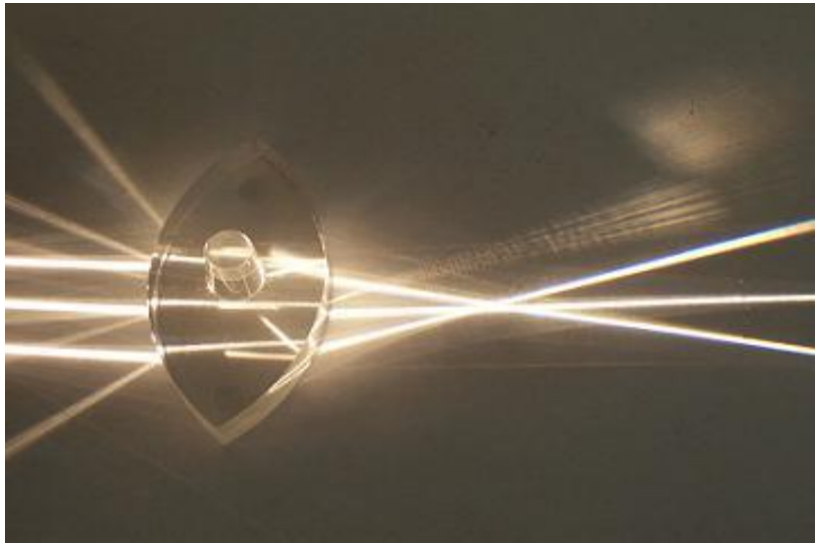
Mirrors vs. Lenses

Mirrors	Lenses
Opaque	Transparent
Reflected Rays	Refracted Rays
Incident Rays and Reflected Rays	Incident Rays and Emergent Rays
Converging = Concave Diverging = Convex	Converging = Convex Diverging = Concave

Image Formation in Lenses

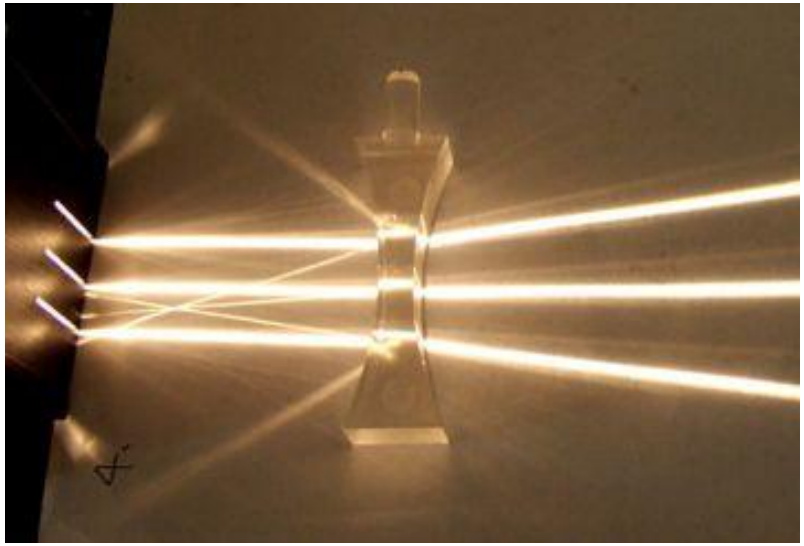
- The examples below illustrate how lenses can distort light.

Convex



Converging Lens

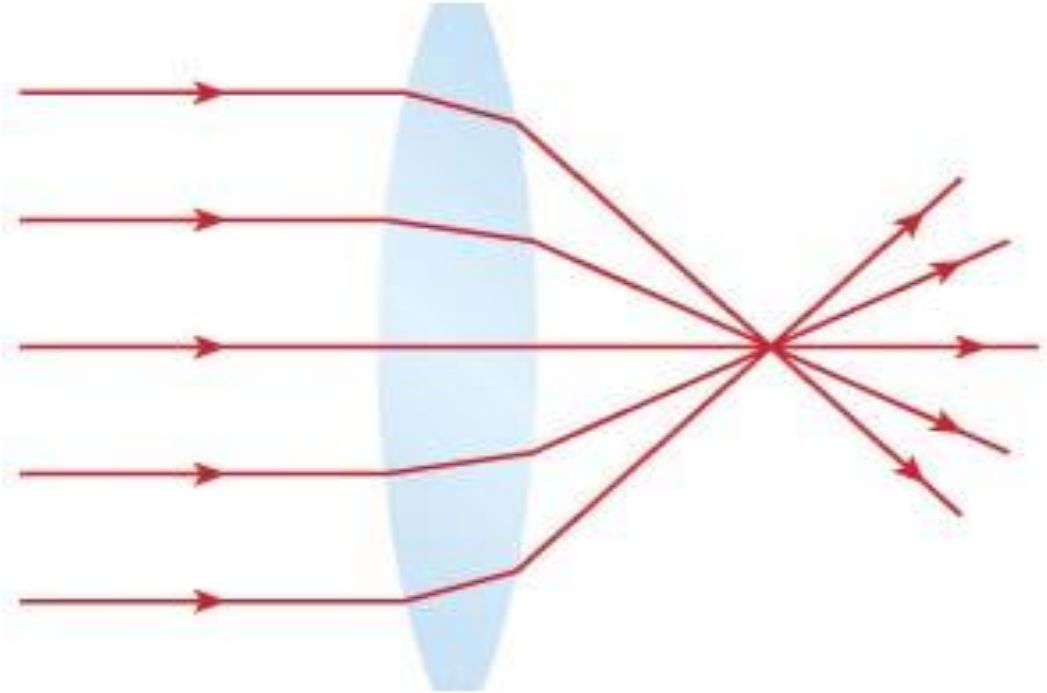
Concave



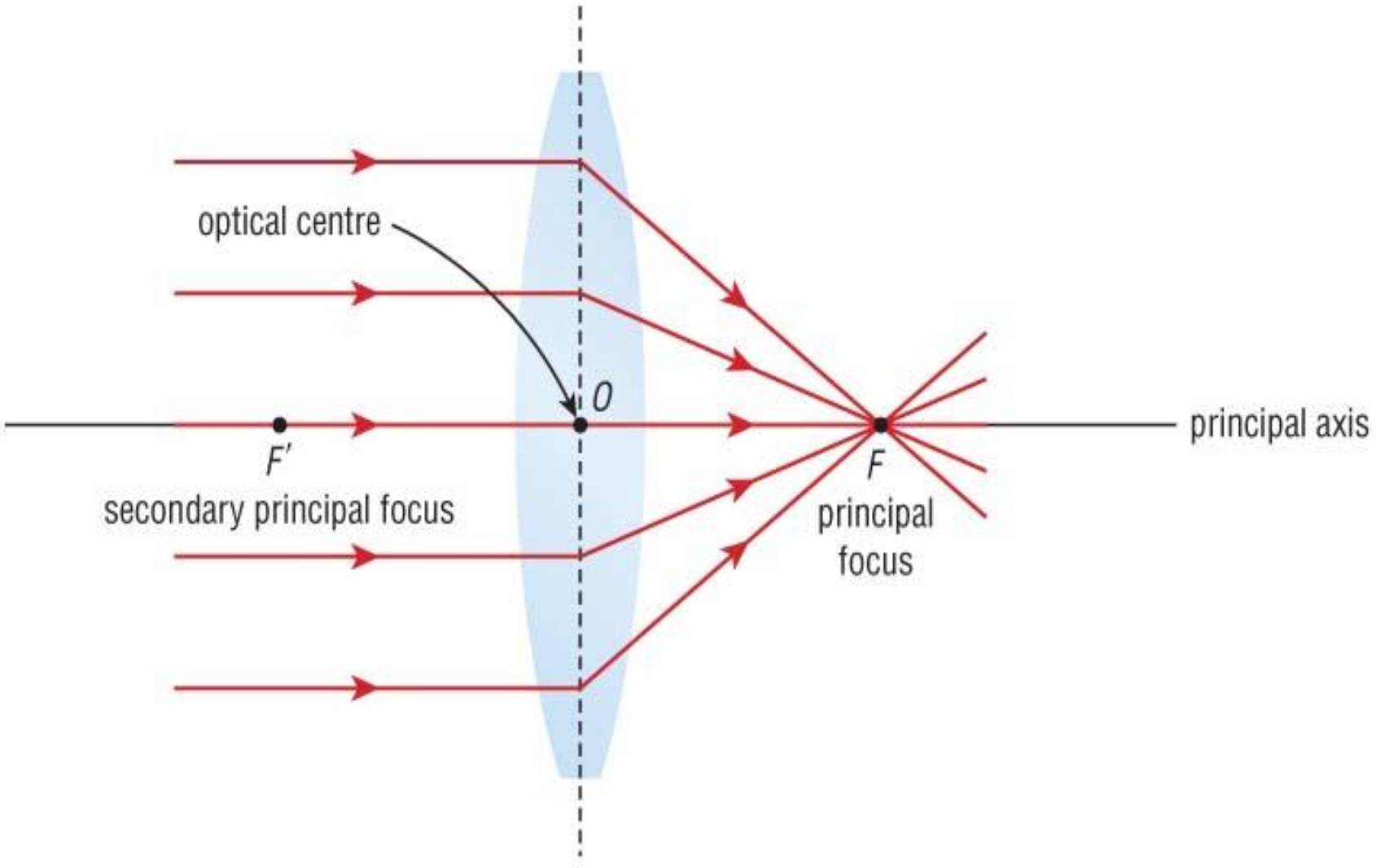
Diverging Lens

Converging Lenses

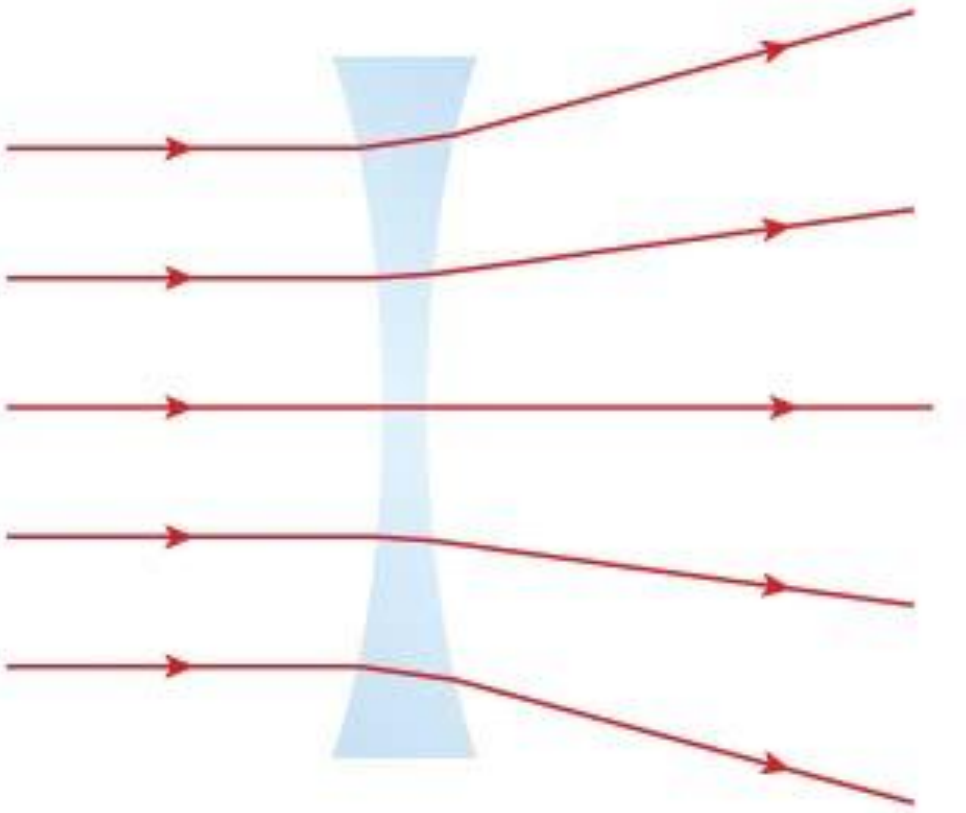
- A **converging lens** causes light rays that are parallel to the principal axis to converge, or meet, at one point (the **principal focus**).



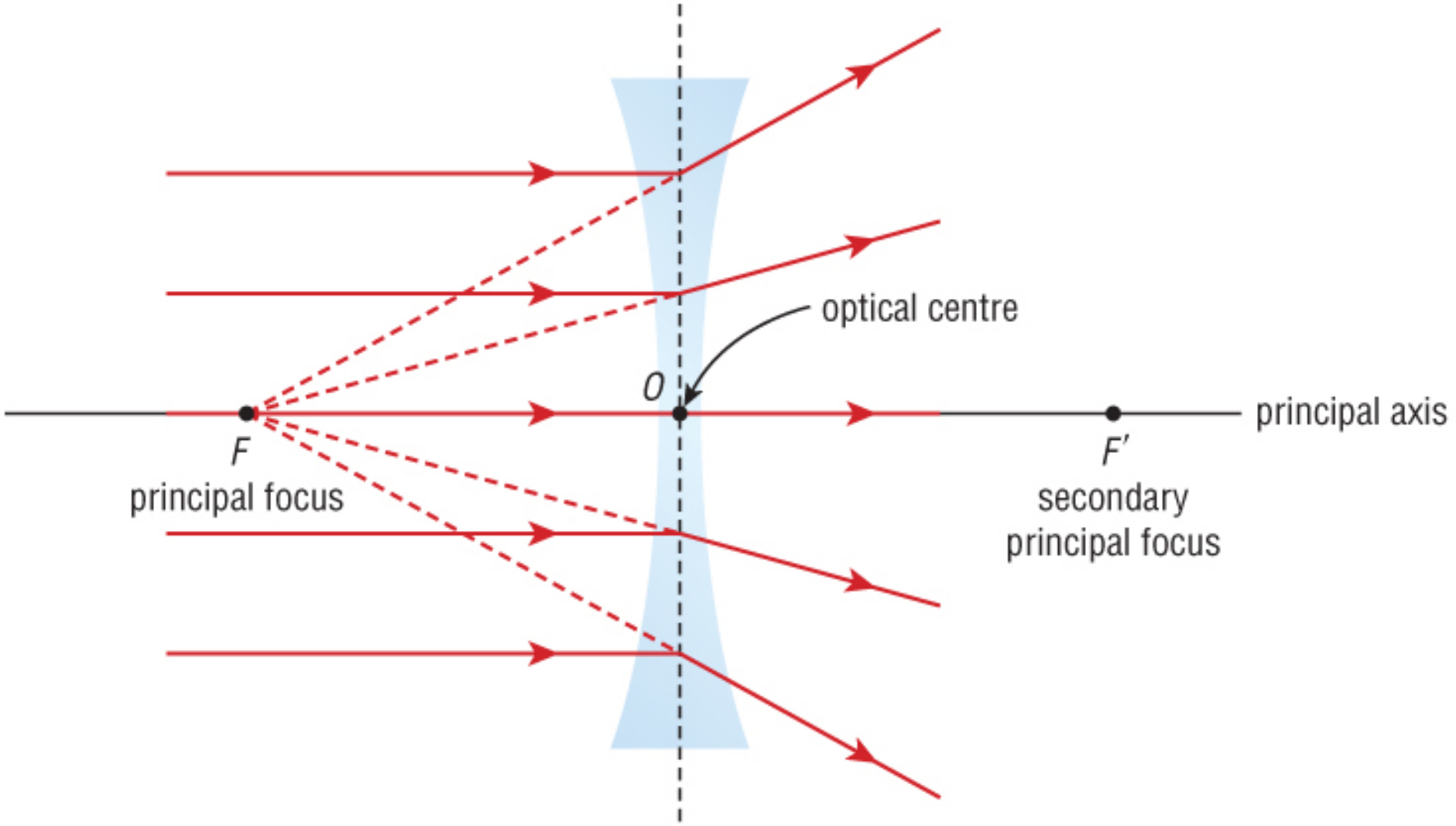
Converging Lens with labels



- A **diverging lens** causes parallel light rays to diverge, or spread apart.



Diverging Lens with labels

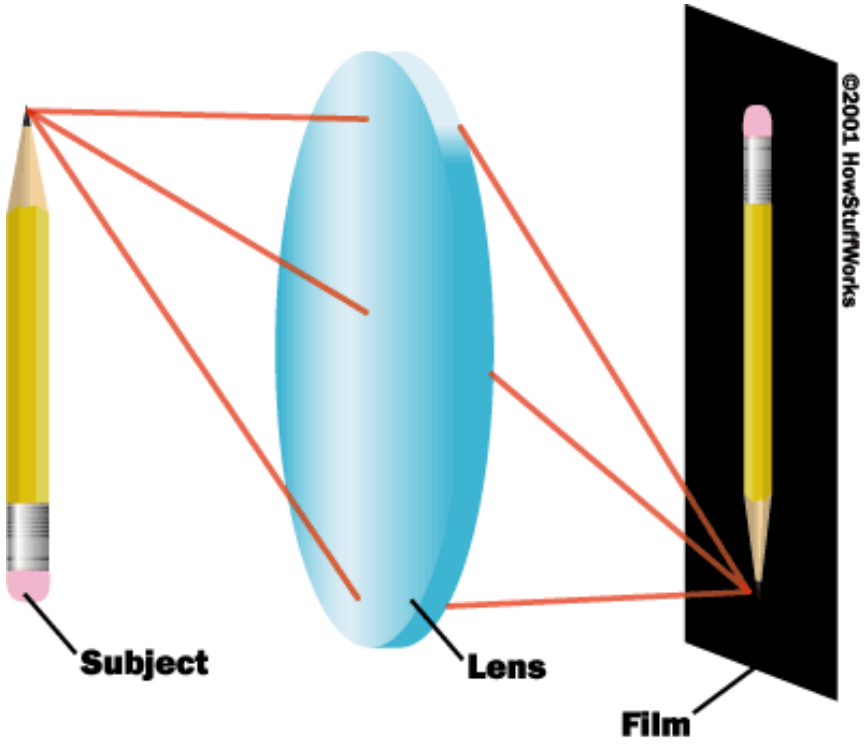


- Objects will also be distorted when viewed through a lens.

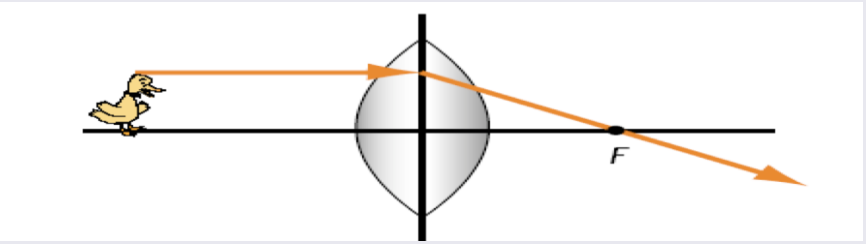
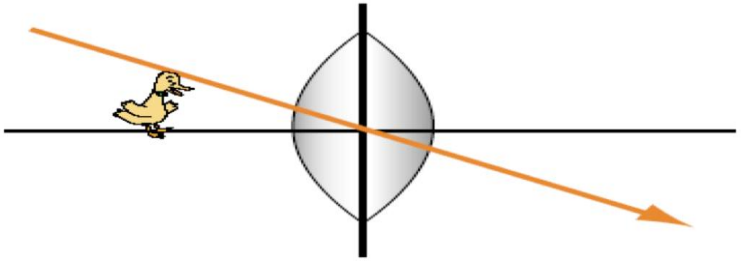
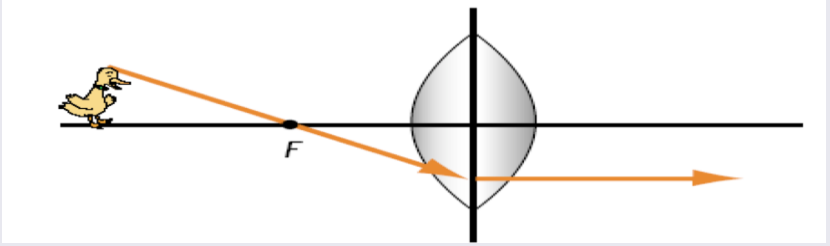
Convex

Concave

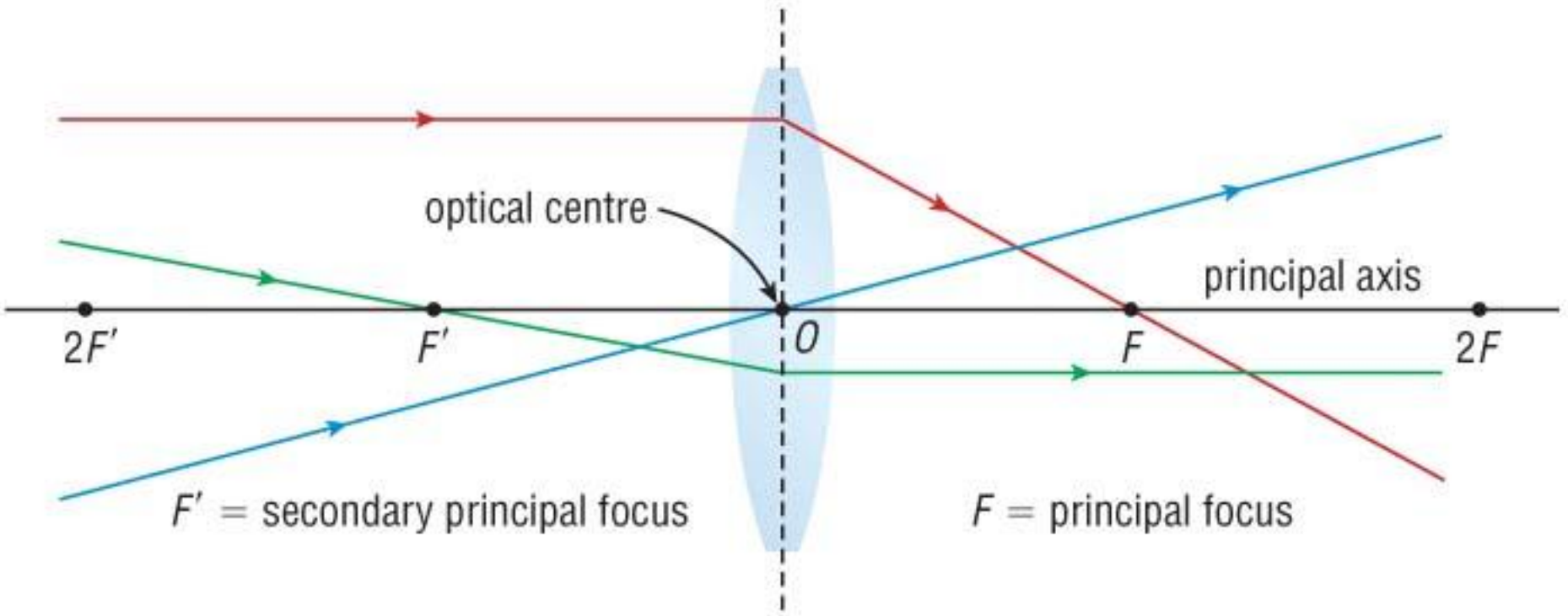
- We can use ray diagrams to predict how an image will look through a lens.



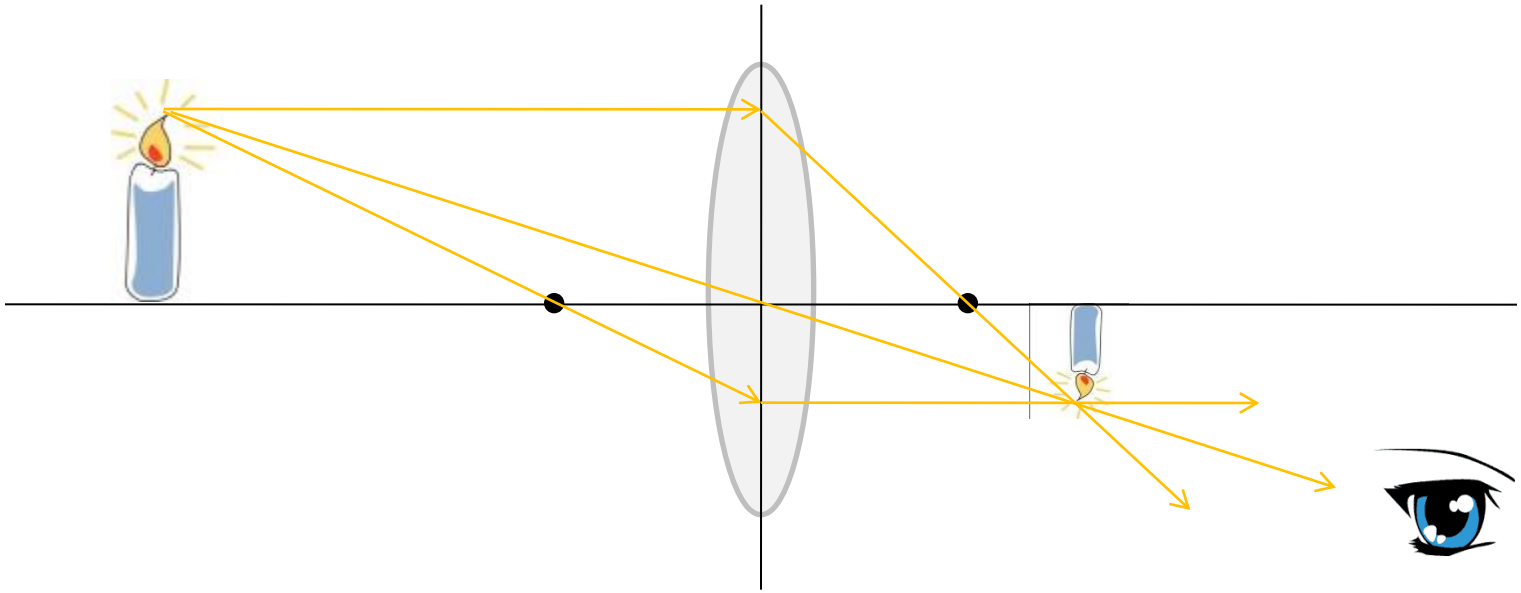
Rules for Converging Lens Ray Diagrams

Incident Ray	Refracted Ray	Diagram (Thin lens)
Parallel to Principal Axis	Through focus	
Through optic Centre	Ray moves along same path	
Through focus	Parallel to principal axis	

Summary of Rules for Converging Lenses

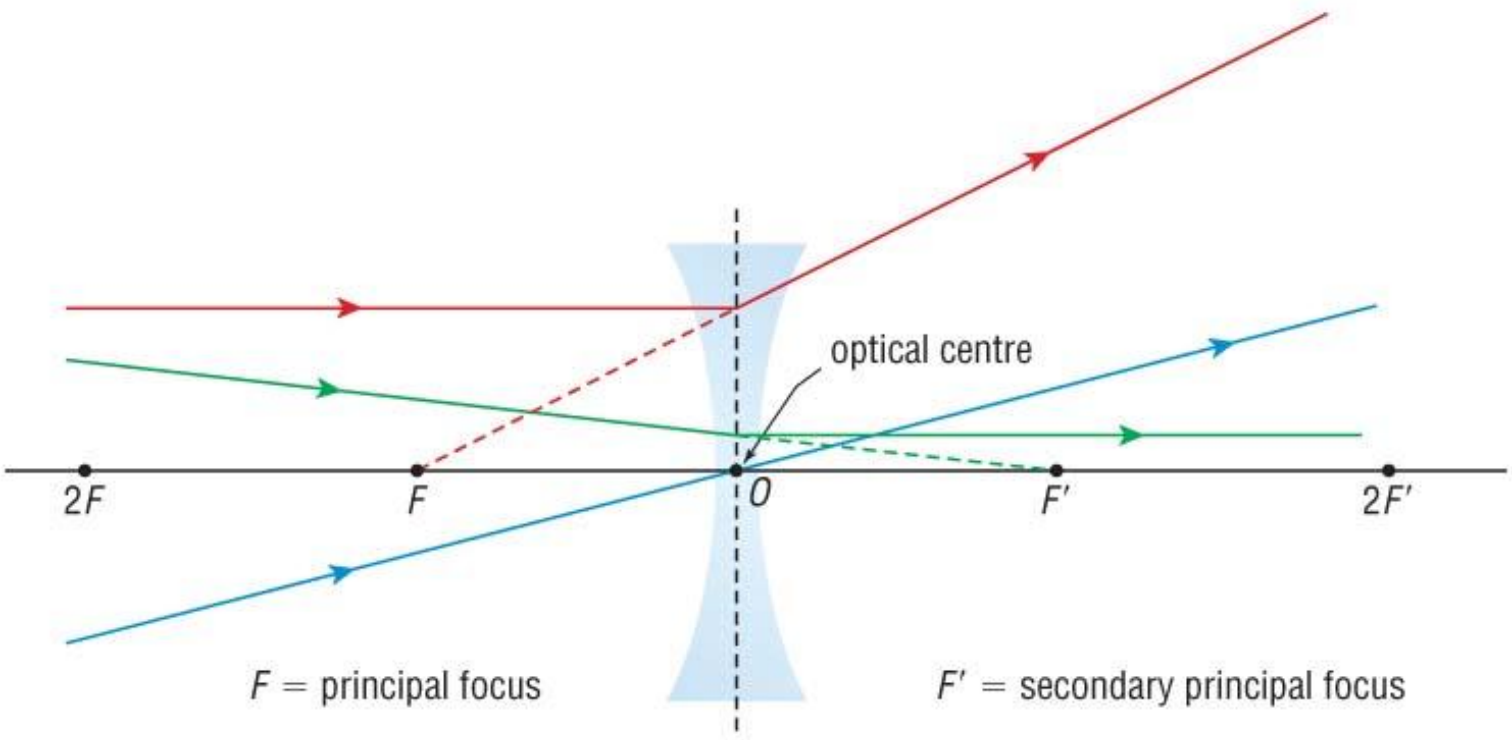


- Consider the following situation:



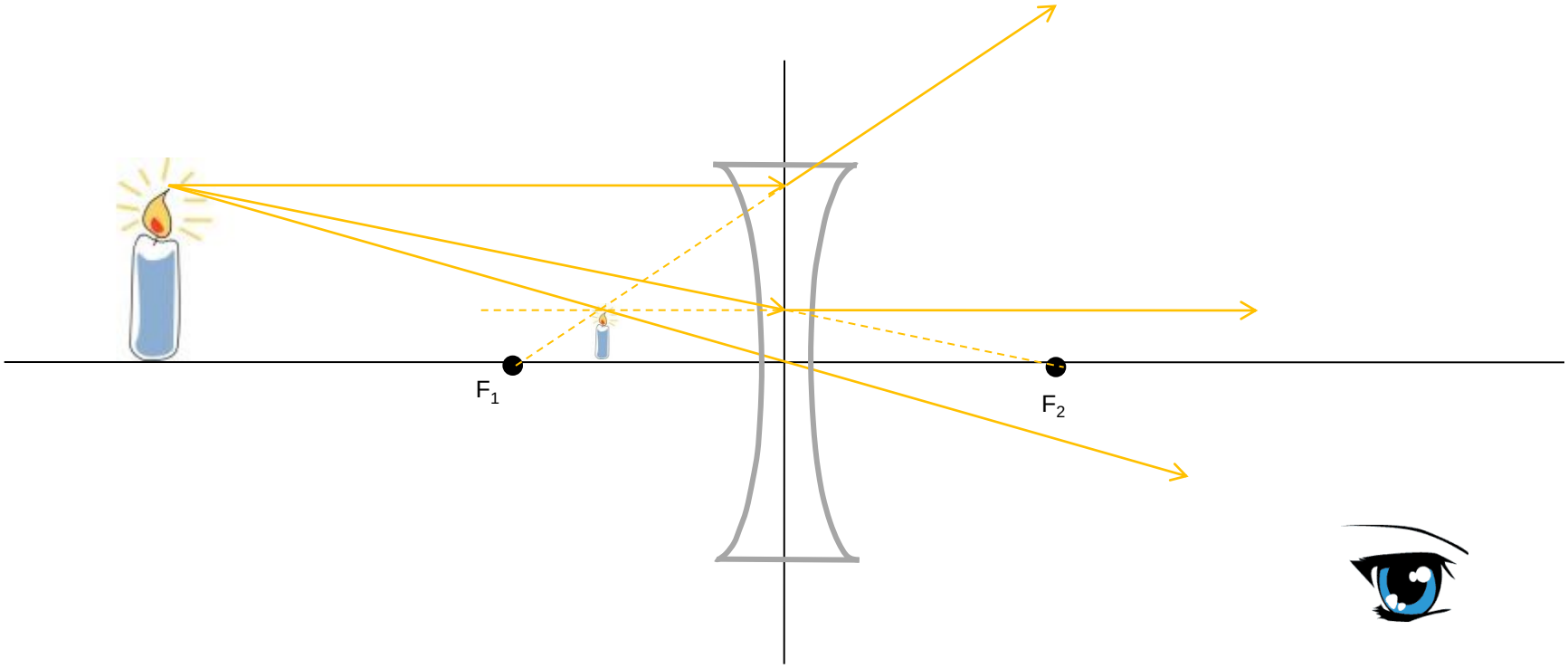
Remember the point where the lines intersect is where the image is formed. Notice that if you looked at **this** candle through **this** convex lens, the candle would appear smaller and inverted!

Rules for Diverging Lens Ray Diagrams



1. A ray parallel to the principal axis is refracted as if it had come through the principal focus (F).
2. A ray that appears to pass through the secondary principal focus (F') is refracted parallel to the principal axis
3. A ray through the optical centre (O) continues straight through on its path

- Consider the following situation:



Notice that if you looked at **this** candle through **this** concave lens, the candle would appear smaller.

Describing Images

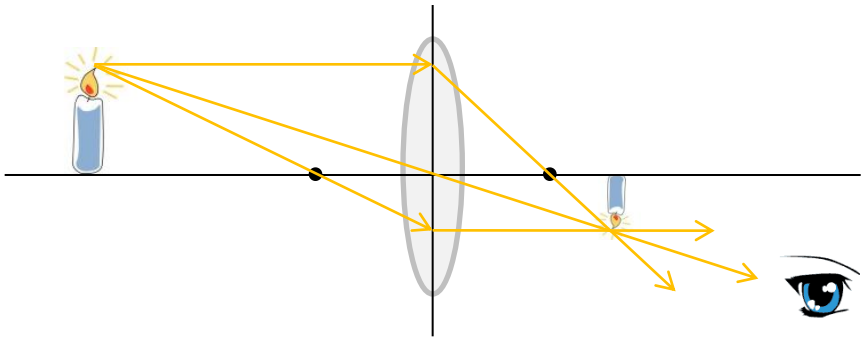
- We describe how an image looks by explaining how each of the four variables below change.

	Image Characteristics	Description
S	Size (or Magnification)	Enlarged or Diminished
A	Attitude	Upright or Inverted
L	Location	Object side or Opposite side of lens
T	Type	Real or Virtual

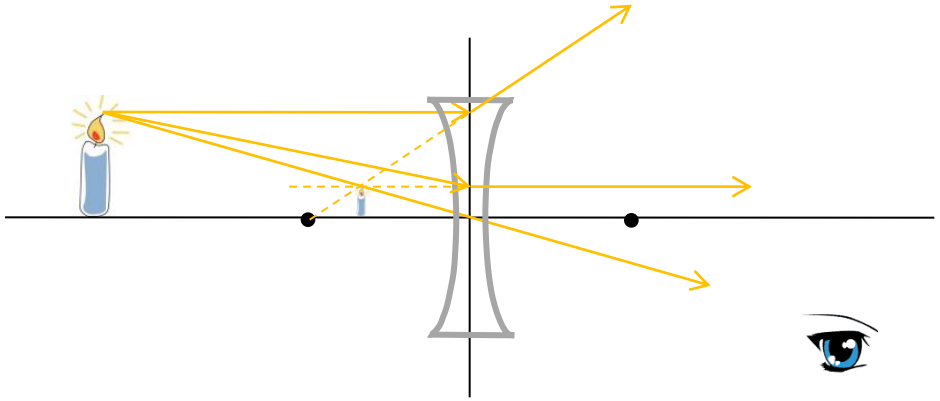
What is a Virtual Image?

- A virtual image is an optical illusion.
- You can see an image, but no light is actually there. It simply appears to be there!

Real Image Formed



Virtual Image Formed



Real and Virtual Images

- A **real image** can be projected on a screen
- A **virtual image** can be seen but cannot be projected on a screen.

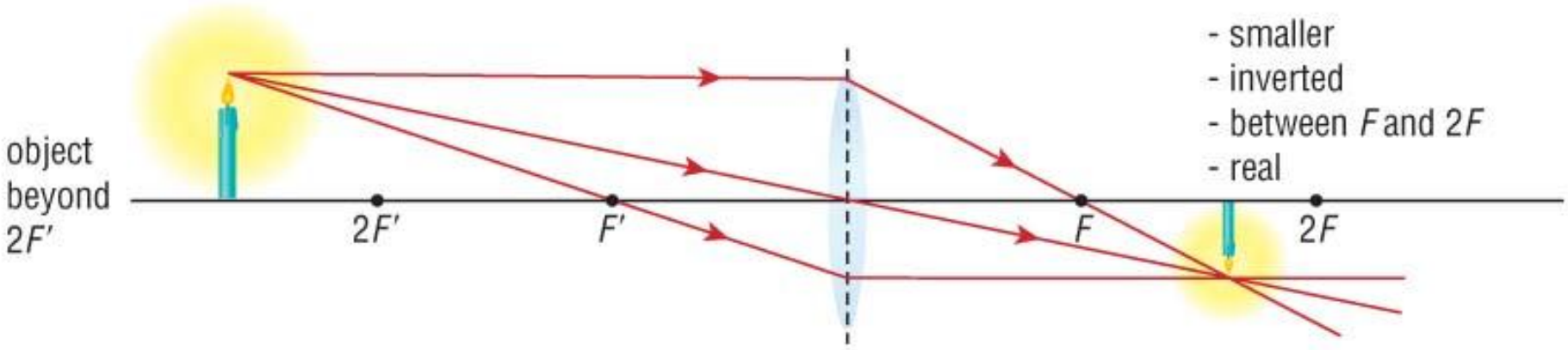
Practice Drawing: Expert Groups

- Instructions: Draw ray diagrams for the following converging lenses and provide a S.A.L.T summary at the end.
- Group 1: Object Beyond 2F’
- Group 2: Object at 2F’
- Group 3: Object Between 2F’ and F’
- Group 4: Object on F’
- Group 5: Object Before F’
- Group 6: Test 1 Diverging Lens

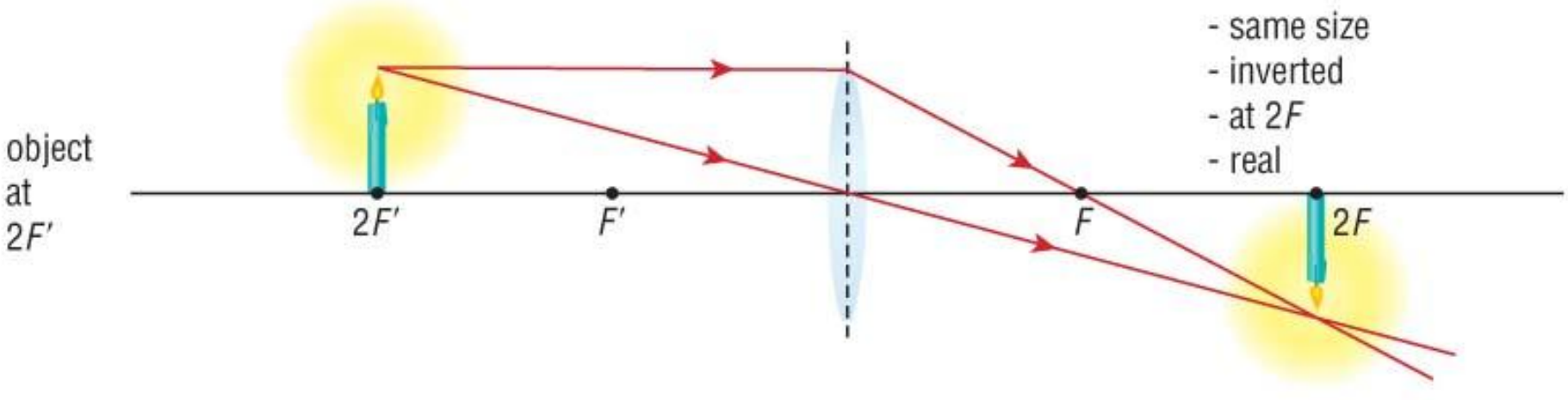
Go back to Home Teams

- Each group must have one expert from each original group.
- Your task: To guide your group through the drawing you perfected. Have them draw it too!
- At the end, everyone should have 4 drawings and 4 L.S.A.L.T tables!

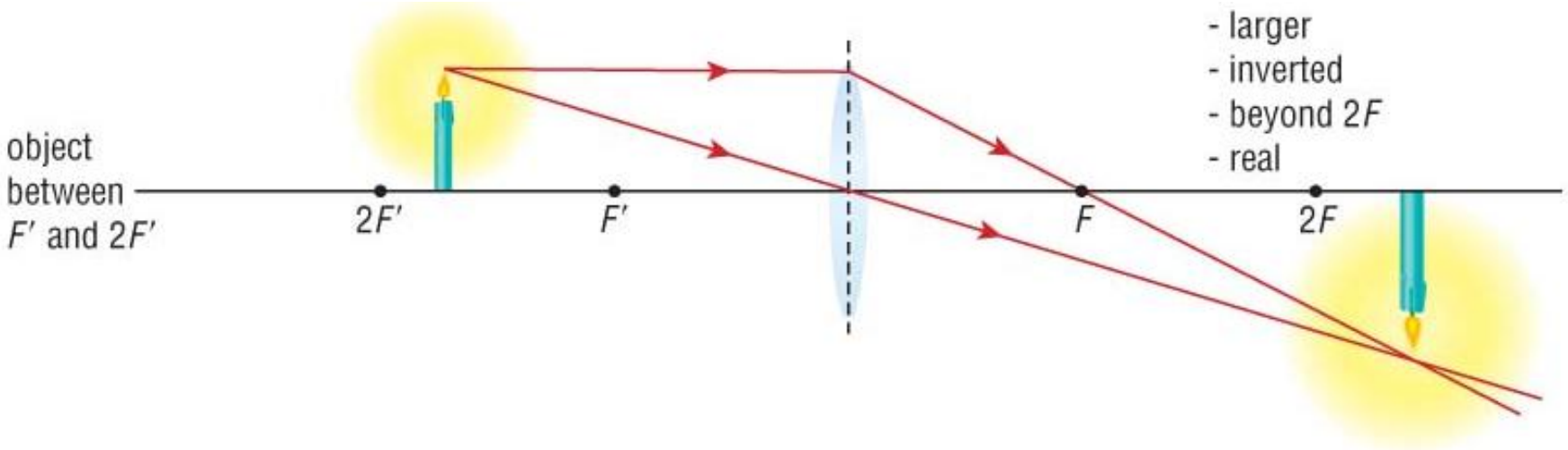
Object beyond 2F’



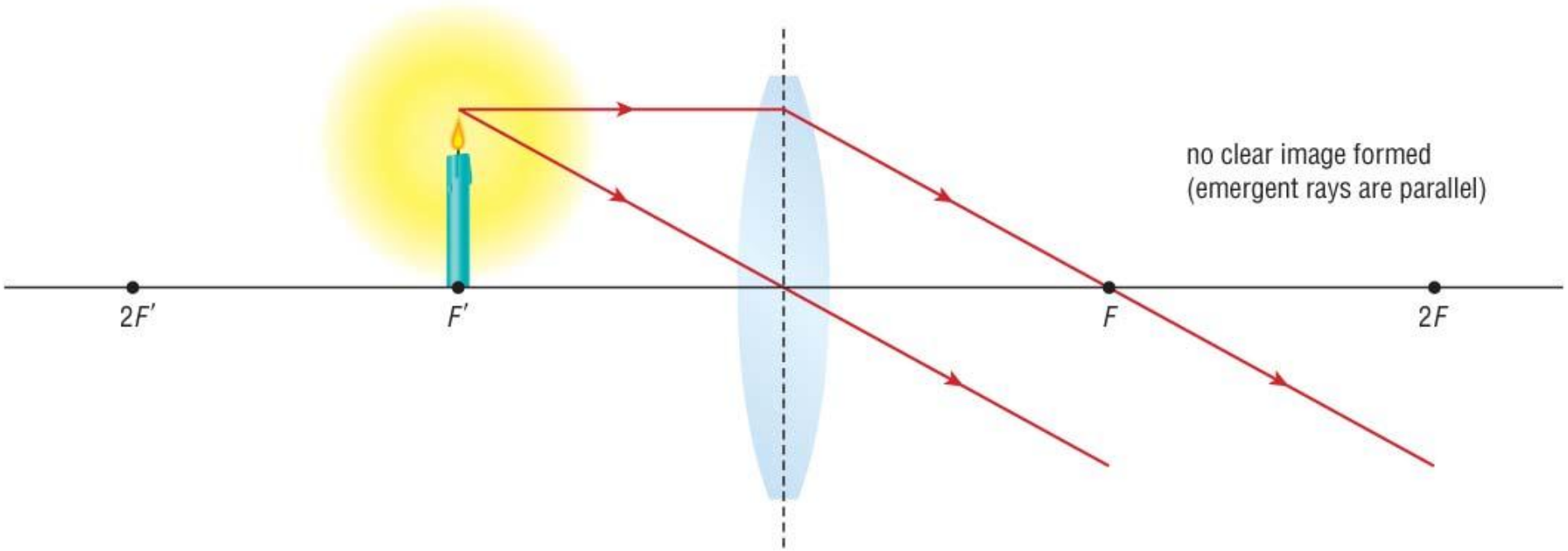
Object at 2F’



Object between F’ and 2F’

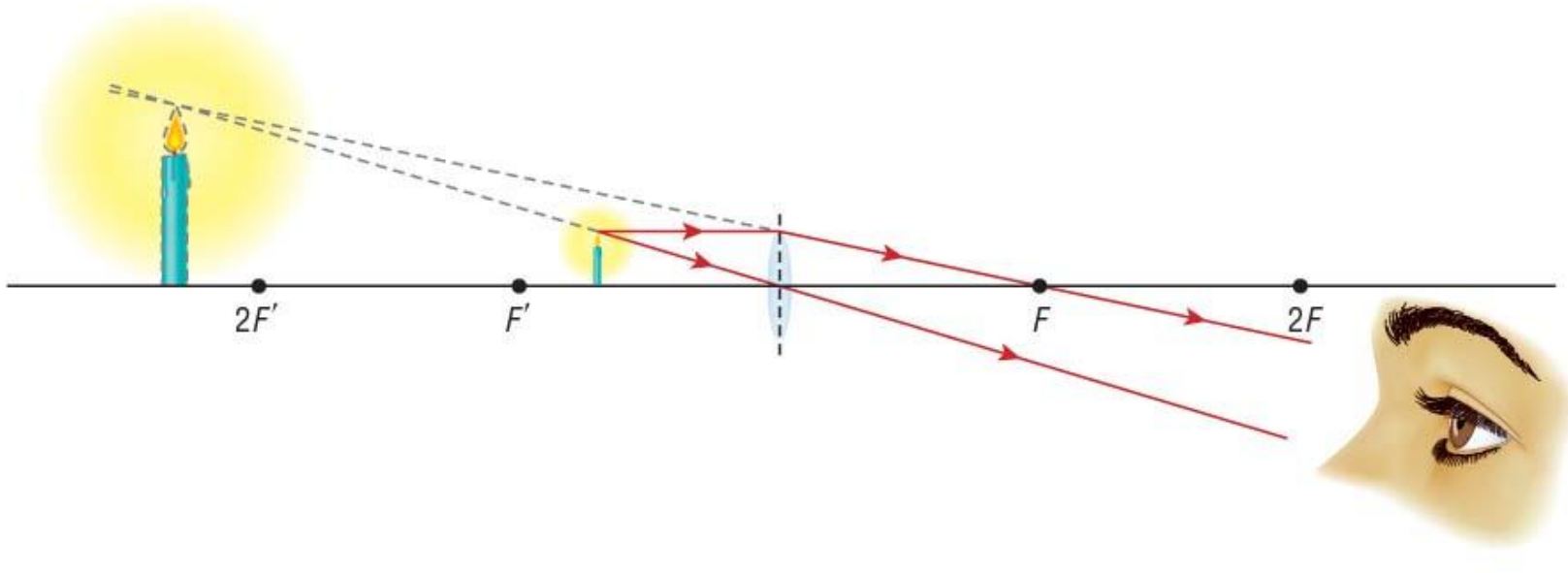


Object at F’

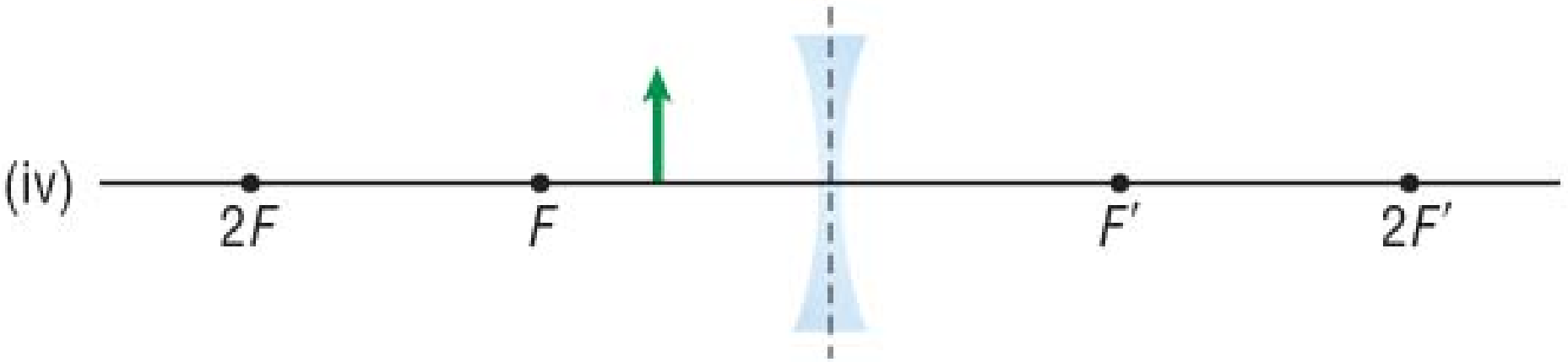


Object between F’ and the Lens

- larger
- upright
- behind the lens
- virtual



Object in a Diverging Mirror



Diverging Mirror

- smaller
- upright
- same side as object
- virtual