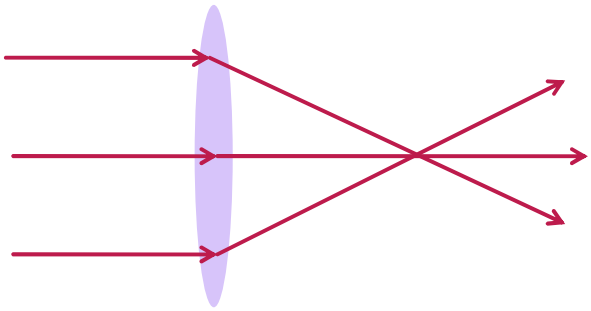
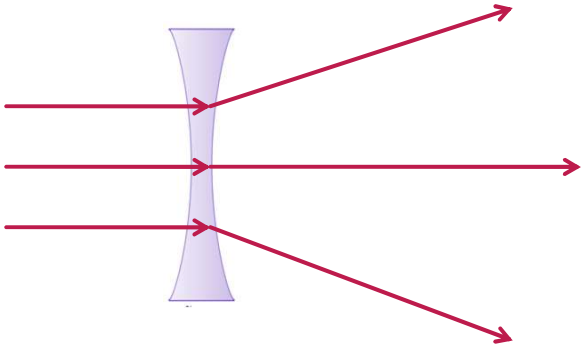
Lenses

Converging Lens



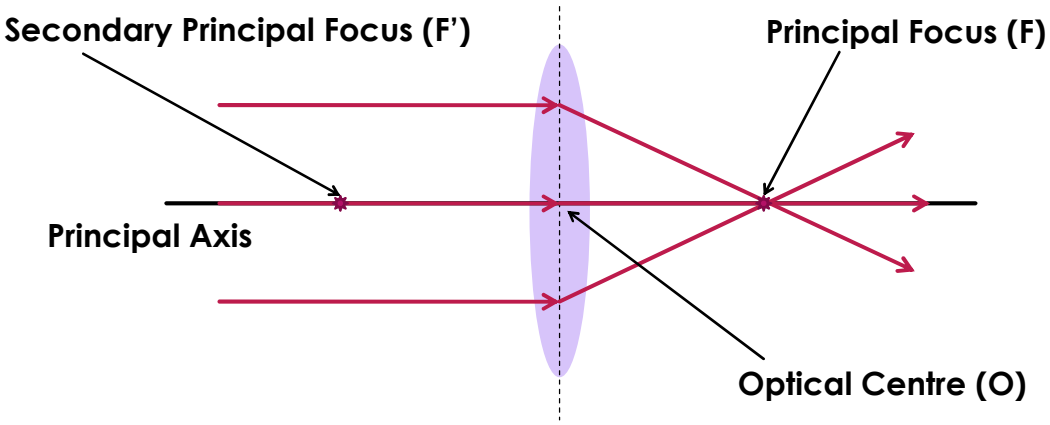
- Light Rays go through the lens and bend towards each other
- They CONVERGE or meet

Diverging Lens

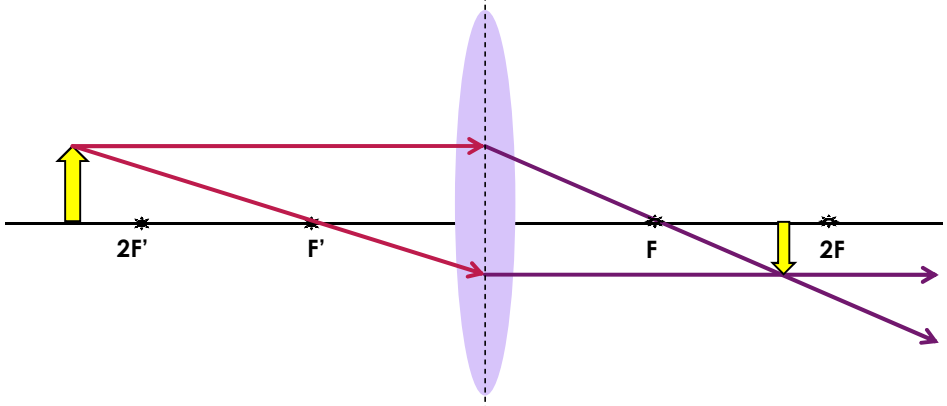


- Light Rays go through the lens and bend away from each other
- They DIVERGE or spread out

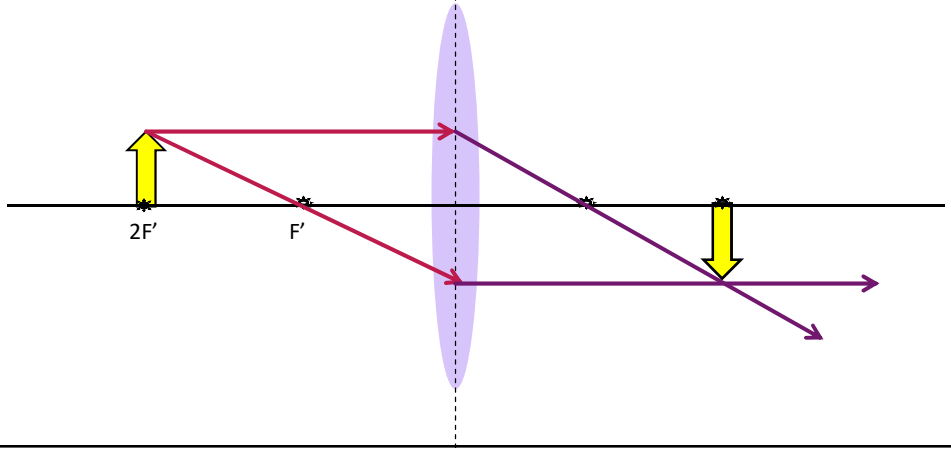
Terminology



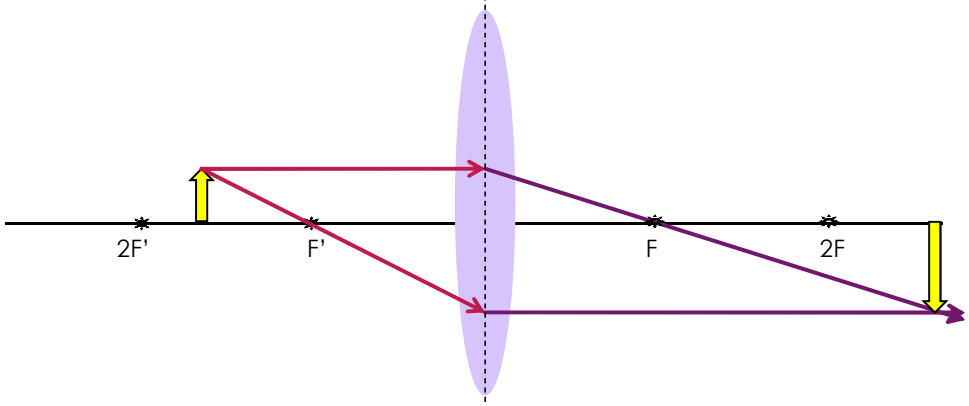
Object is beyond 2F’



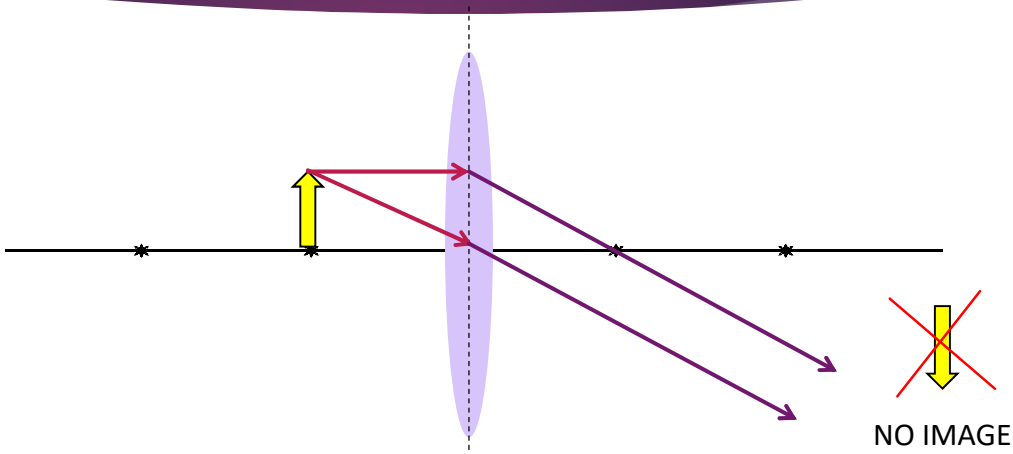
Object is at 2F’



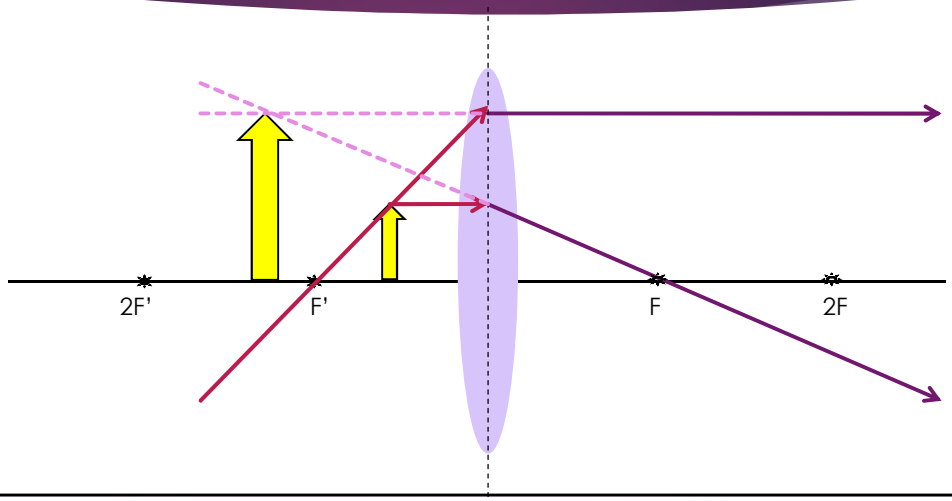
Object is between F' & 2F'



Object is at F'



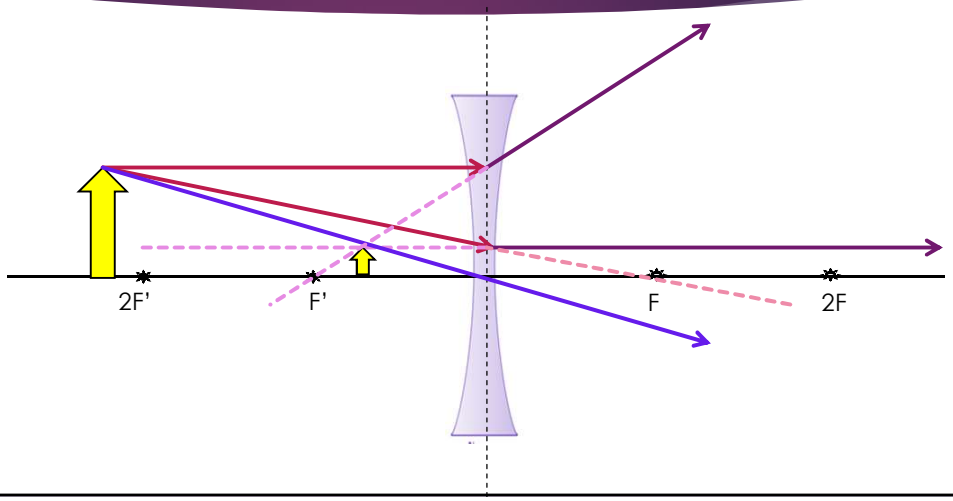
Object is before F'



Converging Lens Summary

- Object beyond 2F' creates an image that is smaller, inverted, between F and 2F and real.
- Object at 2F' creates an image that is same size, inverted, at 2F and real.
- Objects between F' and 2F' create an image that is larger, inverted beyond 2F and real.
- Objects at F' do not produce an image.
- Objects between F' and the lens create an image that is larger, upright, behind the lens, and virtual.

Images in a Diverging Lens



Diverging Lens Summary

- Ray parallel with principal axis will bend towards the principal focus
- A straight line through the optical centre
- Ray through the secondary principal focus will bend and travel parallel to principal axis
- All images are smaller, upright, same side as the object, and virtual

Thin Lens Equation

- The **distance of the object from the lens**, d_o, **distance of the image from the lens**, d_i, and the **focal length of a lens**, f, can all be related using the **thin lens equation:**

$$\frac{1}{d_0} + \frac{1}{d_i} = \frac{1}{f}$$

- Keep in mind:
  - Concave lens has –ve focal length, and –ve distance to image
  - Convex lens has +ve focal length, and +ve or –ve distance to image (depending on location of object)
  - d_i is +ve if REAL, -ve if VIRTUAL

Example Problem

- **A convex lens of a magnifying glass is held 2.00 cm above a page to magnify the print. If the image produced by the lens is 3.60 cm away, and is virtual, what is the focal length of the magnifying glass?**

Given: d_o = 2.00 cm;
d_i = -3.60 cm

Unknown: f = ?

Equation: $\frac{1}{d_0} + \frac{1}{d_i} = \frac{1}{f}$

1/2.00 cm + 1/-3.60 cm = 1/f
0.5 cm^{-1} – 0.278 cm^{-1} = 1/f
0.222 cm^{-1} = 1/f ***(flip both sides)***
4.50 cm = f

Therefore, the focal length of the magnifying glass is 4.50 cm

Homework

- Q#1-4 on p. 454
- Practice Problems (9 total) on pp. 455-457