Chapter 23
Light: Geometric Optics

Lecture 2

The University of Jordan/Physics Department

Prof. Mahmoud Jaghoub

أ.د. محمود الجاغوب

23-7] Thin Lenses; Ray Tracing

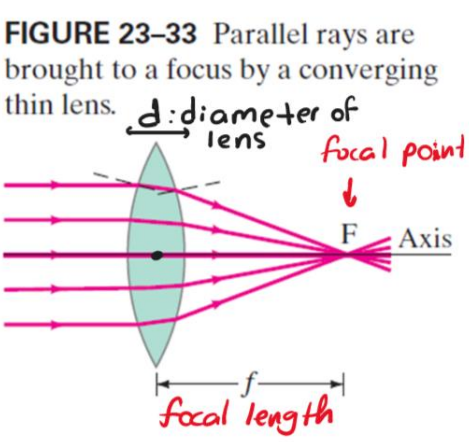
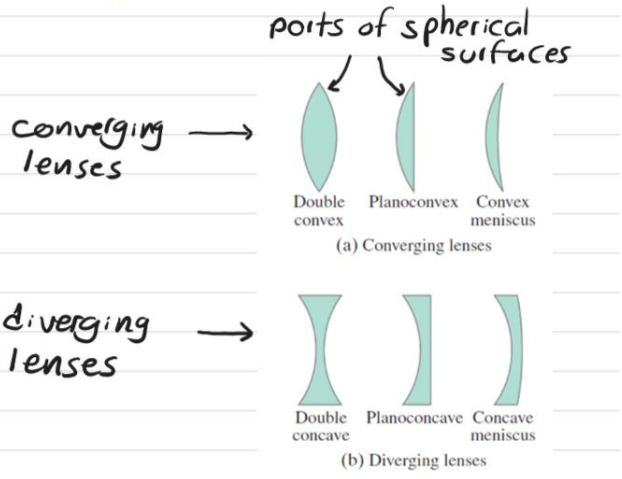
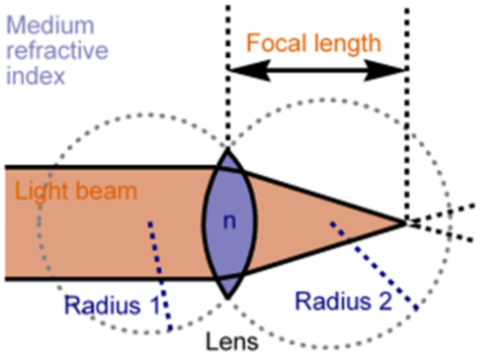


FIGURE 23–33 Parallel rays are brought to a focus by a converging thin lens.



When diameter of lens (d) $\ll$ radius of curvature
$\Rightarrow$ lens is called a thin lens.

Radius 1: radius of curvature of right hand side of spherical surface of the lens.

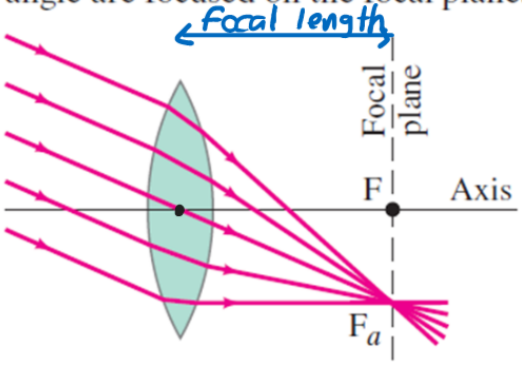


Radius2: radius of curvature of left hand side spherical surface of the lens.

Rays that are parallel to the principal axis refract passing through the focal point ⇒ converging lens.

Parallel rays falling on the lens at an angle are focused on a point F_a that lies on the focal plane.

FIGURE 23–35 Parallel rays at an angle are focused on the focal plane.



• center of the lens.

Diverging lens: it diverges the parallel rays falling on it.

Refracted rays seem to originate from the focal point F.

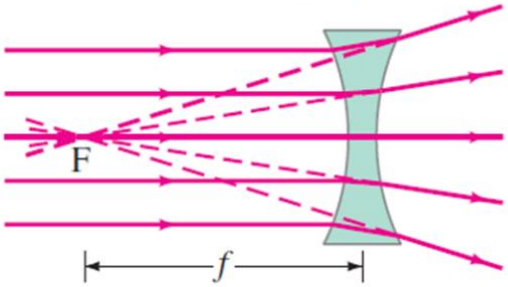


FIGURE 23–36 Diverging lens.

focal length

Lens Power

Optometrists and Opthalmologists define the lens power as

$$P = \frac{1}{f}$$, f is the focal length

A lens whose focal length $f = 20\ cm = 0.2\ m$ has a lens power of

$$P = \frac{1}{0.2} = 5\ m^{-1} = 5\ D$$

↑ diopter

So the unit used for lens power is diopter $D \equiv m^{-1}$

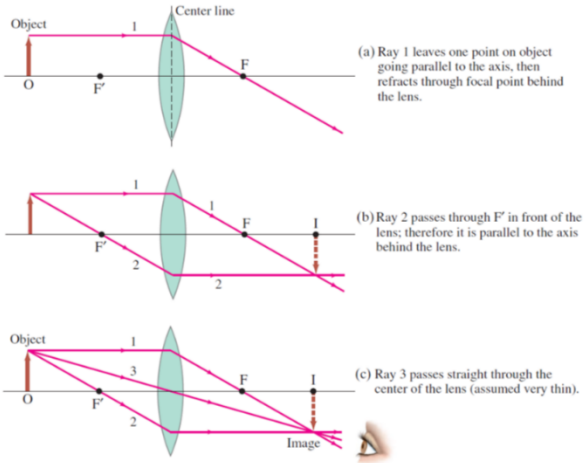
Determining the position of the image of an object

Need to draw three rays:

Ray ① falls parallel to the lens axis is refracted through the focal point

Ray ② passes through the focal point (F' in front of the lens) is refracted parallel to the lens axis.

Ray ③ it passes through the center of the thin lens as shown.



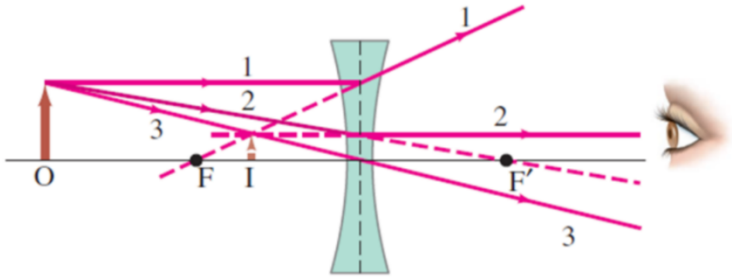
The image of the tip of the of the arrow is at the position of intersection of the three rays. The same technique can be applied to all points of the object ⇒ leading to the image shown in the figure.

The image is a result of intersection of the actual rays and can be observed on a screen ⇒ Real Image.

Diverging Lens

It diverges the refracted rays as shown.

The refracted rays appear as if they originate from the focal point (F) infront of the lens.



To determine the positon of the image, we need three rays as shown.

Ray ① : Incident parallel to the lens axis. It is refracted such that it extrapolatron passes through the focal point (F).

Ray ② : It falls on the lens such that its extrapolation passes through the focal point (F'). This ray is refracted parallel to the lens axis.

Ray ③ : It passes through the center of the lens and passes through the thin lens along the same direction.

The same can be done to find the position of the image corresponding to all the other points on the object

All refracted rays seem as if they originate from a point on the left of the lens, which is the position of the image. This is a virtual image since it is NOT formed at the point of intersection of the rays.