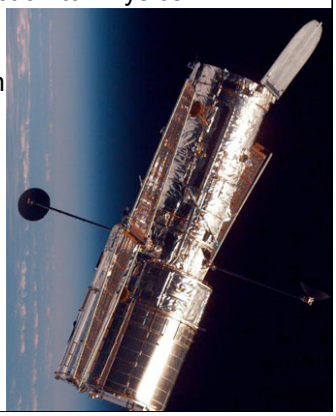
PHY132H1F Introduction to Physics II
Class 6 – **Outline:**

- Thin Lens Equation
- Image Formation
- Lenses Used in Combination
- Vision
- Telescopes
- Microscopes



Quick Ch. 24 reading quiz..

With what unit is *lens power* measured?

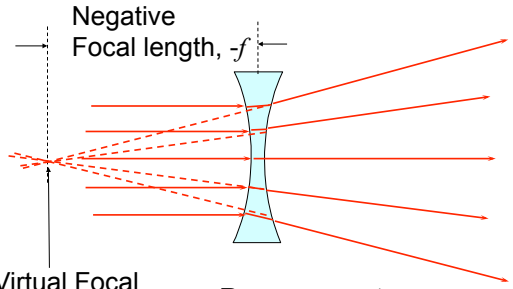
A. Biopter
B. Diopter
C. Watt
D. Rayleigh
E. Lens Responsibility

Quick Ch. 24 reading quiz..

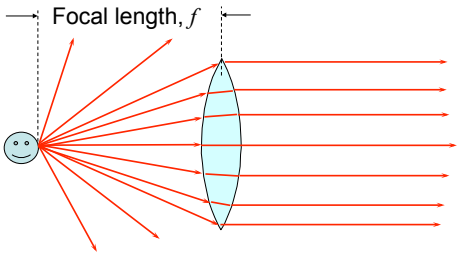
Accommodation of the eye refers to its ability to

A. rotate in the eye socket to look in different directions.
B. focus on both nearby and distant objects.
C. see in both very bright and very dim light.
D. see both in air and while underwater.
E. adjust to a last minute change of plans.

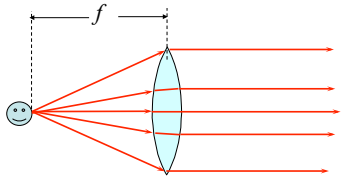
Diverging Lens



What happens when diverging rays pass through a Converging Lens?

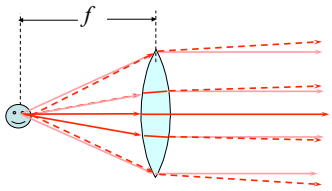


A point source of rays placed exactly one focal length away from a converging lens will produce parallel rays after passing through the lens.



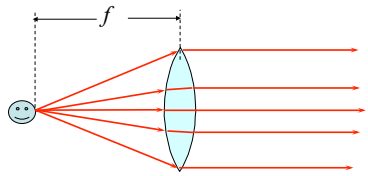
What will happen to the rays emerging to the right of the lens if the face is moved a little closer to the lens?

A. They will remain parallel.
B. They will diverge (spread out).
C. They will converge (toward a focus).



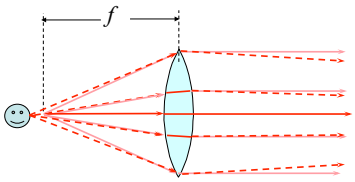
What will happen to the rays emerging to the right of the lens if the face is moved a little closer to the lens?

B. They will diverge (spread out).



What will happen to the rays emerging to the right of the lens if the face is moved a little further away from the lens?

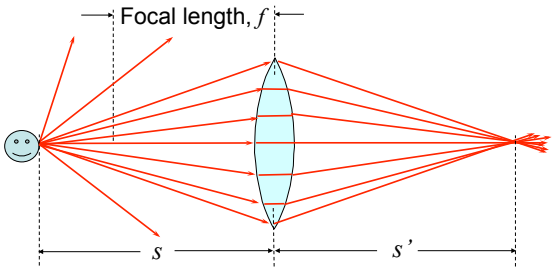
A. They will remain parallel.
B. They will diverge (spread out).
C. They will converge (toward a focus).



What will happen to the rays emerging to the right of the lens if the face is moved a little farther away from the lens?

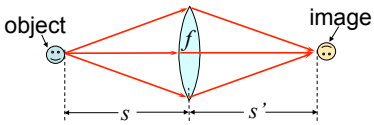
B. They will converge (toward a focus).

Diverging rays through a Converging Lens



Thin Lens Equation: $\boxed{\frac{1}{s}+\frac{1}{s'}=\frac{1}{f}}$

Thin Lens Equation: sign conventions



$$\boxed{\frac{1}{s}+\frac{1}{s'}=\frac{1}{f}}$$

s is positive for objects to the left of lens, negative for objects to the right of lens (virtual objects).

s' is positive for images to the right of lens, negative for images to the left of lens (virtual images).

f is positive for converging lenses, negative for diverging lenses.

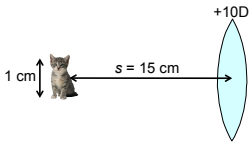
Magnification

$$|M| \equiv \frac{h'}{h} \qquad M = -\frac{s'}{s}$$

- The absolute magnitude of the magnification $|M|$ is defined to be the ratio of image height to object height.
- A positive value of M indicates that the image is upright relative to the object. A negative value of M indicates the image is inverted relative to the object.
- Note that when s and s' are both positive, M is negative.

Example 1

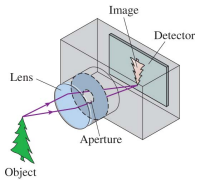
- A lens has a focal power of +10 D.
- A 1 cm high object is placed 15 cm in front of the lens.
- Where does the image form, how large is the image, and is it upright or inverted?



s'?

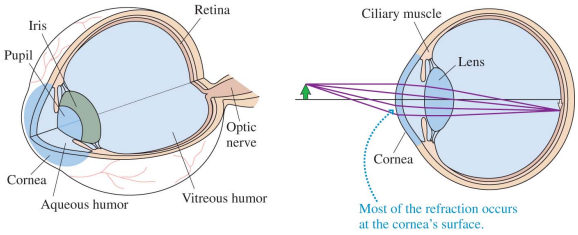
The Camera

FIGURE 24.3 A camera.



- A **camera** "takes a picture" by using a lens to form a real, inverted image on a light-sensitive detector in a light-tight box.
- We can model a combination lens as a single lens with an **effective focal length** (usually called simply "the focal length")
- A *zoom lens* changes the effective focal length by varying the spacing between the converging lens and the diverging lens.

FIGURE 24.6 The human eye.

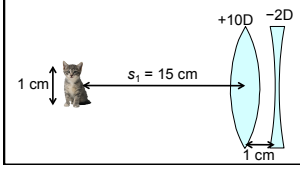


Lenses used in combination

- If one or more lenses are used in combination, the object of the second lens is the image of the first lens.
- The thin lens equation can be applied to several lenses in sequence, always setting the image of the previous lens to be the object of the next.

Example 2

- Lens 1 has a focal power of +10 D.
- A 1 cm high object is placed 15 cm in front of lens 1.
- Lens 2 has a focal power of –2 D. It is placed 1 cm beyond lens 1.
- Where does the image form, how large is the image, and is it upright or inverted?



s_2'?

FIGURE 24.4 A simple camera lens is a combination lens.

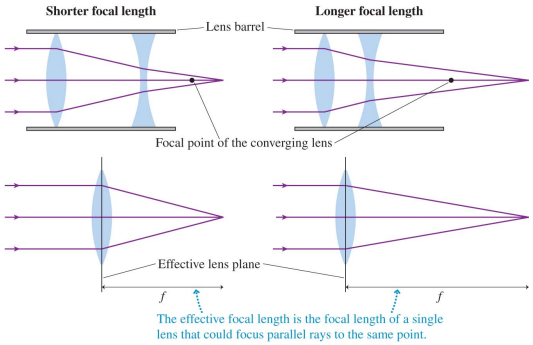
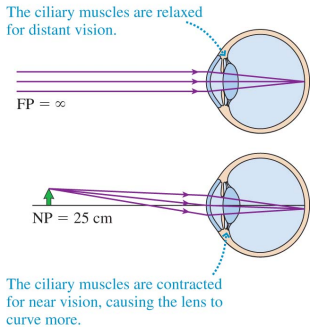


FIGURE 24.8 Normal vision of far and near objects.



Before Next Class:

- Finish Problem Set 2 on MasteringPhysics tonight before midnight!

- On Friday you will be tracing actual light rays as they pass through or reflect from real optical elements such as prisms and lenses.

- Please read Chapter 25. The test on Oct. 12 will cover Chapters 20 – 25 (excluding Ch.22)

- Try the suggested end-of-chapter problems for Chapter 24

See you Monday!