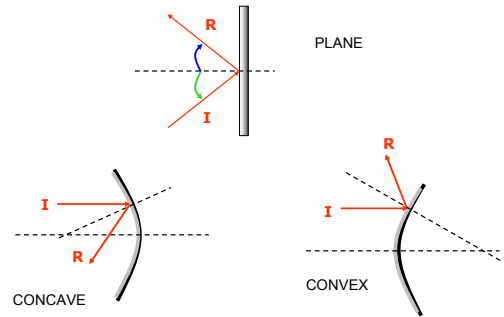


L 33 Light and Optics [3]

- images formed by mirrors
 - plane mirrors
 - curved mirrors
 - concave
 - convex
- Images formed by lenses
- the human eye
 - correcting vision problems
 - nearsightedness
 - farsightedness
 - astigmatism
 - depth perception

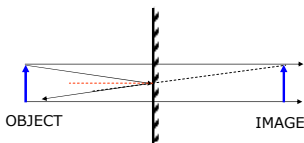
Law of reflection

angle of incidence = angle of reflection



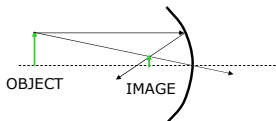
VIRTUAL image: light rays appear to come from a point where there is no light

REAL image: light rays actually converge at image location



PLANE MIRROR

- Image is VIRTUAL
- Same size as object
- Upright
- Same distance behind mirror



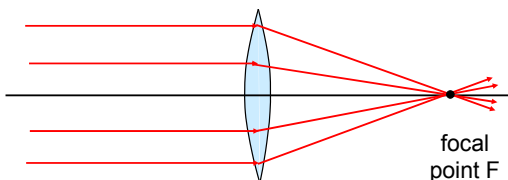
CONCAVE MIRROR

- Image is REAL
- Upright
- smaller than object

Image formation with lenses

- converging lens (positive lens)
 - diverging lens (negative lens)
 - the human eye
 - correcting for nearsightedness
 - correcting for farsightedness
 - optical instruments
- lenses are relatively simple optical devices
 - the principle behind the operation of a lens is refraction → the bending of light as it passes from air into glass (or plastic)

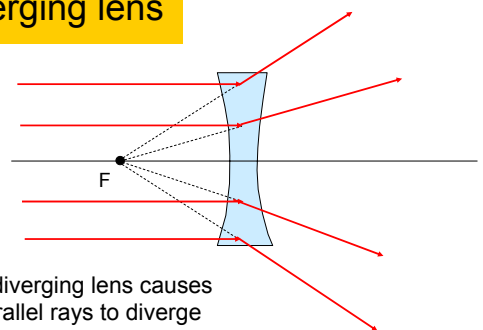
converging lens



→ a converging lens focuses parallel rays to a point called the focal point.

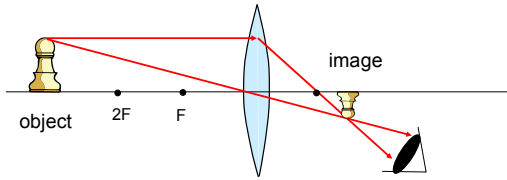
→ a thicker lens has a shorter focal length

Diverging lens



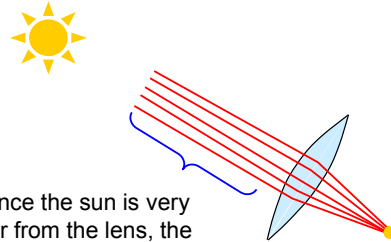
A diverging lens causes parallel rays to diverge as if they came from a focal point F

Image formation by a converging lens



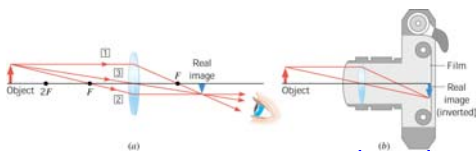
- If the object is located at a distance of at least $2F$ from the lens, the image is inverted and smaller than the object.
- The image is called a **REAL** image since light rays actually converge at the image location

A converging lens is used to focus rays from the sun to a point



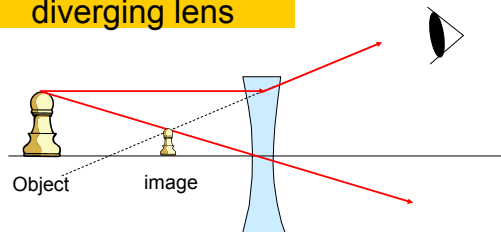
- since the sun is very far from the lens, the rays are nearly parallel

converging lens is used in a camera to focus light onto the film



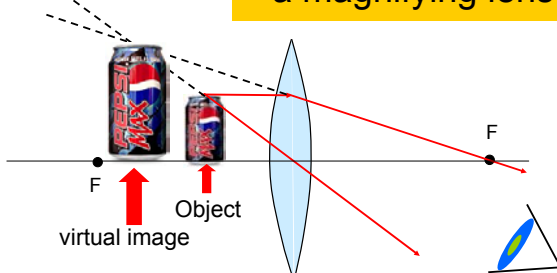
- when you focus a camera, you adjust the distance between the lens and the film depending on the object location.

Image formation by a diverging lens



- The diverging lens produces an image that is upright and diminished in size.
- It is a **VIRTUAL** image, since light rays do not actually pass through the image point

a magnifying lens



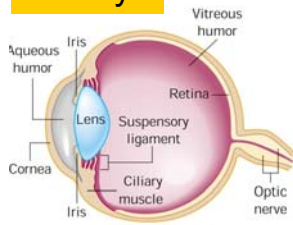
- By placing the lens close to the object we get a magnified virtual image.

Sight – the human eye

- Physics of the human eye
- Abnormal vision
 - Nearsightedness
 - Farsightedness
 - astigmatism
- Depth perception

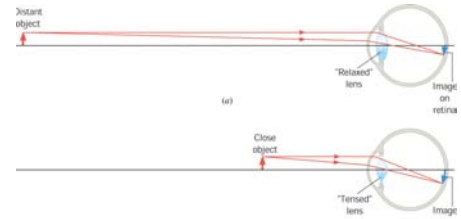
The Eye

- light enters through the cornea
- the iris controls the amount of light that gets in, a muscle can close it or open it, the iris determines your eye color
- the lens is filled with a jelly-like substance; the ciliary muscle can change the shape of the lens and thus change its focal length

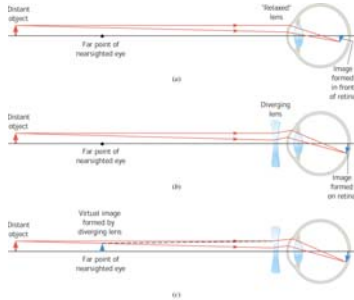


→ by changing the focal length, (**accommodation**) the Lens is able to focus light onto The retina for objects located at various distances

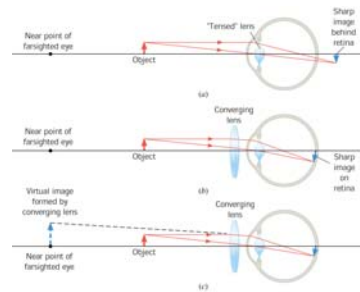
the physics of the human eye



The relaxed eye can easily focus on distant objects. To focus on close objects the lens is squeezed to shorten its focal length, making it possible to converge the rays onto the retina. The **near point** is the distance at which the closest object can be seen clearly. It recedes with age.

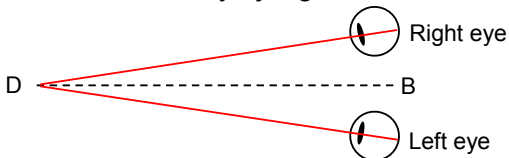


When a **nearsighted** person views a distant object, the lens cannot relax enough to focus at the retina. The rays converge too quickly. The remedy is to place a diverging lens in front of the eye to first diverge the rays before they enter the eye.



When a **farsighted** person tries to focus on a close object the lens cannot be squeezed enough to focus on the retina. The focus point is behind the retina. The remedy is to place a converging lens in front of the eye to converge the rays before they enter the eye.

How does the eye judge distance?

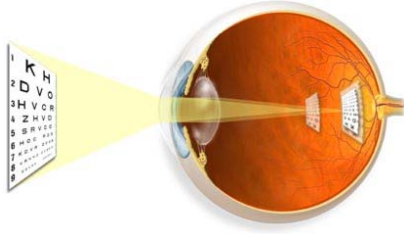


- Our brain interprets the images formed on the retinas of both eyes as a single image → this is called **binocular vision**
- Our eyes roll inward slightly to focus on the distant point D. Our brain interprets the distance BD by the muscular effort required to roll the eyes inward.

astigmatism

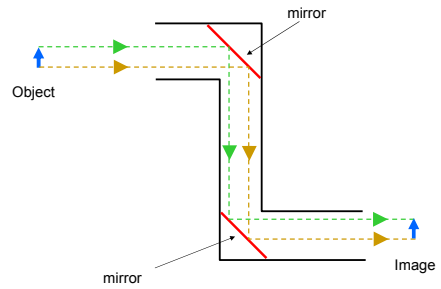
- Astigmatism means that the cornea is oval like a football instead of spherical like a basketball. Most astigmatic corneas have two curves – a steeper curve and a flatter curve. This causes light to focus on more than one point in the eye, resulting in blurred vision.

Astigmatism



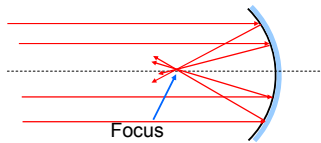
Astigmatism can be corrected with specially shaped lenses or, in extreme cases, with surgery.

Down periscope



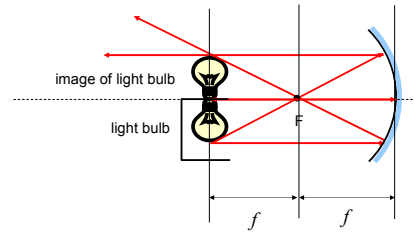
Spherical or curved mirrors

Concave mirror



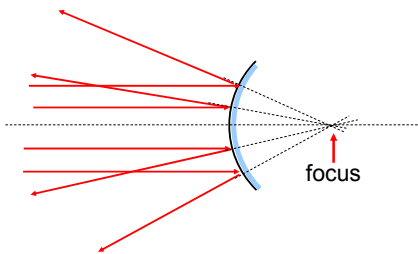
parallel light rays are focused to one point

Where is the light bulb?



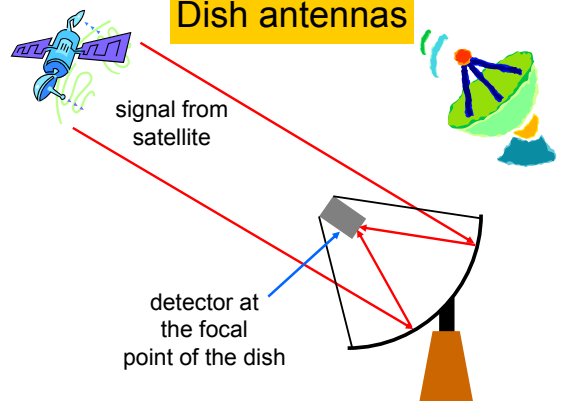
A concave mirror will form a *real* image of an object placed at twice its focal length at a distance of twice the focal length. It will be inverted and the same size as the object.

convex mirror

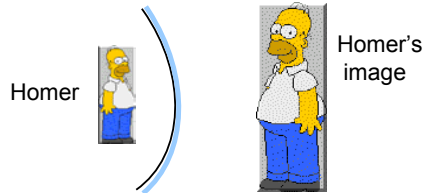


parallel rays diverge from a focus behind the mirror

Dish antennas

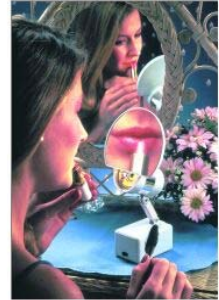


Magnifying mirrors

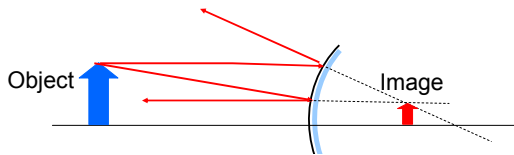


when something placed within the focus of a concave mirror, an enlarged, upright image is formed. this principle is used in a shaving or makeup mirror

A concave mirror can provide a magnified image as used in this cosmetic mirror.



Convex mirrors: wide angle view



A convex lens provides a wide angle view. Since it sees more, the images are reduced in size. Passenger side mirrors are often of this type with the warning: "objects appear further than they actually are". Because they appear smaller they look further away.