

## 1 The Camera

**camera:** lens equipped with a shutter (except in electronic controlled cameras), a light-tight enclosure, and a light-sensitive film or an electronic sensor.

**charge-coupled device (CCD):** a semiconductor chip covered with tiny photocells.

$$f - \text{number} = \frac{\text{Focal length}}{\text{Aperture diameter}} = \frac{f}{D}.$$

## 2 The Projector

**projector:** for viewing slides or motion pictures; consists of concave mirror, lamp, condenser lens, object (LCD array), projection lens, and screen.

## 3 The Eye

- **cornea:** tough, transparent membrane
- **aqueous humor:** liquid behind cornea;  $n \approx 1.336$ , the index of refraction of water
- **crystalline lens:** a capsule containing a fibrous jelly, hard at the center, and progressively softer at the outer portions;  $n \approx 1.437$
- **ciliary muscle:** attaches via ligaments to the crystalline lens
- **vitreous humor:** behind the lens, a thin, watery jelly;  $n \approx 1.336$ , the index of refraction of water
- **retina:** the screen of the eye upon which the image is formed; like the CCD in a camera; consists of rods and cones (in humans)
- **optic nerve:** transmits information from the retina to the brain
- **fovea centralis:** a small (0.25mm diameter) central region of the retina where vision is most acute
- **iris:** in front of the lens, contains the aperture called the **pupil**
- **pupil:** the aperture of the eye which opens and closes to adapt to changing light intensity

**accommodation:** the ability of the eye via ciliary muscle (tension and relaxation) to change the focal length of the lens.

**near point:** the nearest region of distinct vision; changes as humans age.

**far point:** the farthest region of distinct vision; for the normal eye, infinity.

**presbyopia:** the recession of the near point due to loss of flexibility of the lens.

**myopia:** nearsighted; the eye from cornea to retina is too long or the cornea is too curved causing the image to form before the retina.

**hyperopic:** farsighted; the eye is too short or the cornea is not curved enough causing the image to form past the retina.

**astigmatism:** a defect in which the surface of the cornea is not spherical, but is more sharply curved in one plane than another.

**power:** reciprocal of the focal length; used to describe corrective lens (eyeglasses).

**diopter:** unit of power in reference to corrective lenses.

Power in reference to corrective lens is **not** “energy per unit time”.

## 4 The Magnifier

**angular size:** the apparent size of an object depends upon the angle  $\Theta$  subtended by the object at the eye.

**magnifier:** a converging lens used to form a virtual image that is larger and farther from the eye than the object itself allowing the object to be moved closer to the eye.

### *Angular magnification*

Angular magnification  $M$  is the ratio of the angle  $\Theta'$  subtended by an object at the eye when the magnifier is used to the angle  $\Theta$  subtended without the magnifier:

$$M = \frac{\Theta'}{\Theta}.$$

**Angular magnification**  $M$  (ratio of two angles) is not **lateral magnification**  $m$  (the ratio of image to object height)!

## 5 The Microscope

**microscope or compound microscope:** a device providing great magnification of small objects using the principle that an image formed by one optical element (lens or mirror) can serve as the object for a second element.

**objective:** a lens that forms a real, enlarged, inverted image

**eyepiece or ocular:** the point at which the final image is formed

## 6 Telescopes

**telescope:** similar to the compound microscope; the image formed by an objective is viewed through an eyepiece; used to view objects at a great distance.

**reflecting telescope:** a telescope in which the objective lens is replaced by a concave mirror.

## 7 Lens Aberrations

**aberration:** any failure of a mirror or lens to behave precisely according to the simple formulas developed thus far; lens aberrations are not caused by faulty construction of the lens, but are inevitable consequences of the laws of refraction at spherical surfaces.

**chromatic aberrations:** wavelength-dependent aberration; result of dispersion.

**monochromatic aberrations:** single wavelength light aberration; occur because of limitations of the paraxial approximation.

**spherical aberration:** the failure of rays from a point object on the optic axis to converge to a point image.